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THE HEATING AND VENTILATING MAGAZINE

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Kitchen Ventilation for a Modern Hotel

EQUIPMENT OF THE HOTEL BILTMORE, NEW YORK.

The Hotel Biltmore, in many ways the last word in hotel construction, occupies the entire block bounded by Madison avenue, 43d and 44th streets and Vanderbilt avenue, New York. It is said to be the only hotel in the world that has every room a real outside room.

The plot on which the building stands was known for many years as Commodore Vanderbilt's grazing field. Time after time efforts were made to purchase this valuable piece of property, but during the commodore's lifetime, he would never place a valuation upon it. It was assumed by many that the grass plot would always remain, but when the new Grand Central Terminal was built, the owners decided to put the plot to use.

The architects, Warren & Wetmore, were given unusual opportunities to provide not only a house of safety, with all the necessary fireproof features, but also a house of wholesome living conditions, and they made the utmost of their opportunities.

The heating and ventilation of this hotel is one of the most successful installations ever made in this country. It was designed by Clyde R. Place, mechanical engineer for Warren & Wetmore, and installed by Baker Smith & Co., New York.

While the installation is replete with many interesting details, the present article will only attempt to give a brief outline of the heating system and a description of the ventilating equipment of the kitchens.

THREE SEPARATE HEATING SYSTEMS.

The heating system for the hotel is operated on the principle of a down-feed hot water forced circulation, with main return loops at the bottom, with the exception of the low-pressure system, which has supply and return loop on same level.

The installation is divided into three separate systems, each operated independently from one service plant, located at 50th street, between Lexington avenue and Park avenue. The three systems are known as the low pressure system, intermediate pressure system and the high pressure system.

The low pressure system does all the heating work from the fifth floor down, while the intermediate pressure system heats the hotel from the eleventh floor down to the fifth floor, and the high pressure system takes care of all the heating above the twelfth floor, up to the pent house on the roof.

Each system is absolutely independent of the others, with no cross connections between any of them.

The hot water for the heating comes to the hotel and returns therefrom in six 18-in. hot water heating mains, by means of forced pump circulation from

the pumps and heaters in the service plant, and are laid out on the loop principle, thereby insuring the flow of the heating water in one direction.

METHOD OF DISTRIBUTION.

The method of distribution is as follows:

The supply of water for the hot water heating passes from these main subway loops into the building in sub-loops, which rise up through the building and loop horizontally about the building. From these sub-loops the riser branches are taken and the return riser branches are then collected into the return sub-loops which are arranged similar to supply loops, but in the reverse direction, and these sub-loops are carried down through the building and connected into the main return loops.

After the water has passed from the supply sub-loops through radiators, coils and stacks and has, therefore, done its work for heating, it passes into the return branches, thence into the building sub-loops for the returns and then into the large returns into the subway. The travel of the water is always in the same direction.

The radiators throughout the hotel are of a design and construction suitable for hot water heating under forced circulation, and are of heavy construction, made of grey cast iron with extra heavy right and left hand threaded nipples at

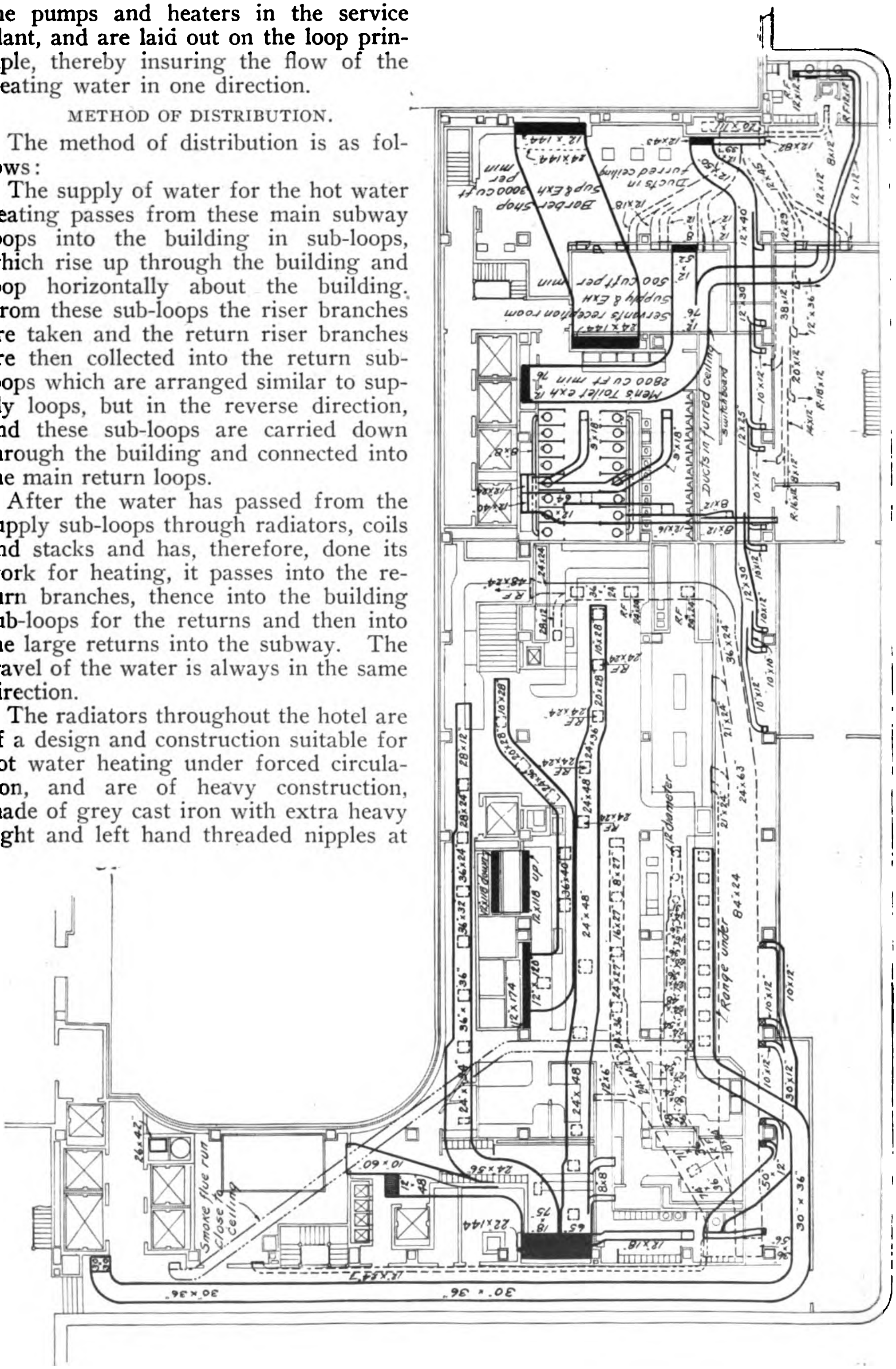
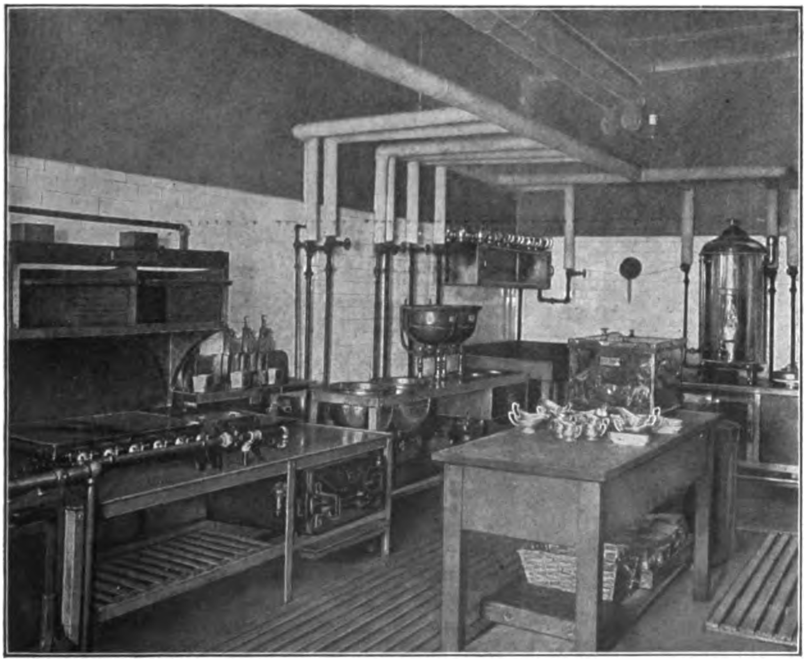


FIG. 1—PLAN OF GRILL, KITCHEN, HOTEL BILTMORE, ON FLOOR LEVEL WITH STATION.

MAIN KITCHEN, BROILING DEPARTMENT, HOTEL BILTMORE.



GRILL KITCHEN, SERVING PANTRY HOTEL BILTMORE.

top and bottom connections with standard $2\frac{1}{2}$-in. sections. Each radiator has been tested to a test pressure of 400 lbs. per square inch and found to be tight at this pressure.

Where radiators are more than 16 sections long, an extra leg is provided, and each radiator has a valve on both the supply and return ends, with a suitable tapping for a brass screw plug for air adjustment on the end section.

The entire heating system is arranged to free itself quickly and readily of all air, by having on the return end sections of radiators a small brass air relief cock key which can be used if the radiator becomes air bound. On the top of each riser and on the top of each supply of each pressure system is an extra heavy $\frac{3}{4}$-in. pipe connection, which is connected to $1\frac{1}{4}$-in. air main carried around parallel to the main supply loops and ending with an open connection in the respective expansion tanks in the building.

Wherever there is any change in elevation of the horizontal loop to form air pockets, these pockets have a relief valve.

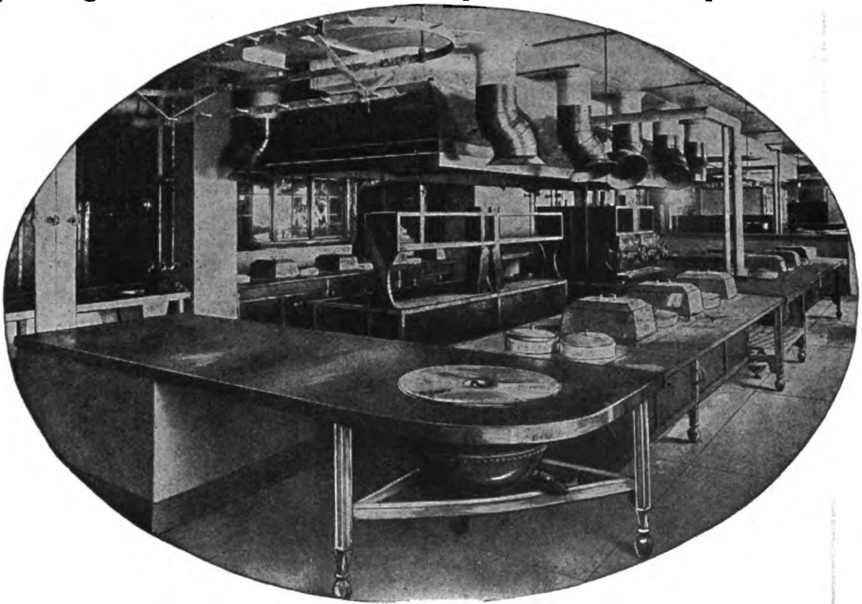
All expansion and contraction in the piping system is taken care of by swings and bends without using sliding joints.

All of the risers have loops which are anchored in proper locations so that no part of the piping is subjected to an expansion greater than $\frac{1}{2}$-in. with the temperature of water from 70° to 210° F., and in the horizontal lines no greater expansion than 1 in. under the same temperature conditions.

All piping is covered with 85 per cent. carbonate of magnesia and is canvas jacketed, painted and then banded.

KITCHEN VENTILATION.

Particularly notable and interesting are the Biltmore's kitchens, all of which are located above ground adjacent to the dining rooms they supply, and planned upon a scale so comprehensive and so unusual as to establish a new mark in this important branch of hotel development.



BANQUET SERVICE KITCHEN, HOTEL BILTMORE.

Efficiency and sanitation completely dominate the kitchen plans. From the elaborate ventilation system, which eliminates all excess moisture and odors, to the smallest detail of equipment, everything speaks the thoroughness and care exercised to provide ideal working conditions, and the importance attached to the maintenance of a sweet and wholesome atmosphere in the departments given over to the preparation and care of food in this great hotel.

The ventilation of the hotel itself consists of two separate and distinct systems, viz: a fresh air supply and an exhaust air system.

The fresh air supply consists in drawing fresh air through screens or washers and discharging the air through a system of galvanized ducts to the several rooms and apartments in the hotel.

The vitiated air exhaust system consists of drawing all impure air from the different rooms by means of ducts and large vent shafts, at the top of which the

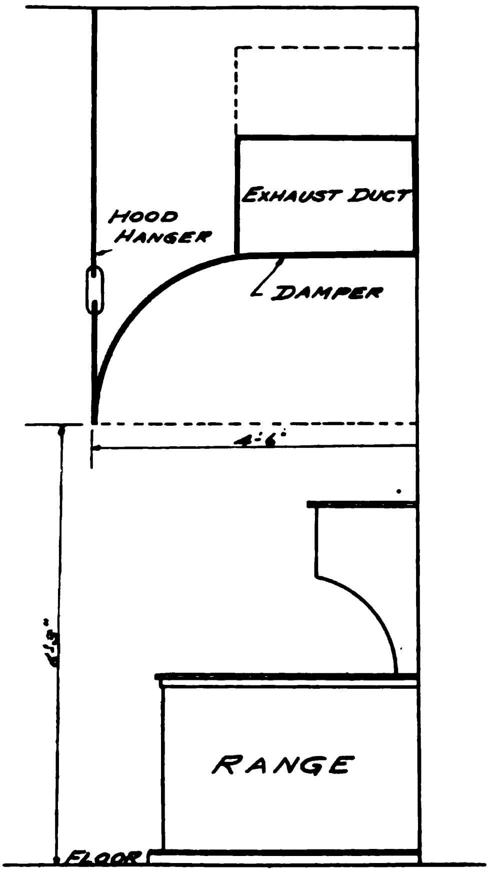


FIG. 2—DETAIL OF EXHAUST DUCT PLACED OVER EACH RANGE, SOUP AND STRAINING KETTLE.

exhaust fans (which throughout the hotel are motor-driven) are placed on the roof in the pent house, and discharge the air into the open.

Fig. 1 shows a plan of the grill kitchen on the floor level with the station, with the fresh air ducts shown in heavy dotted lines, while the exhaust air system is shown in heavy full lines.

As for the dampers, the general rule

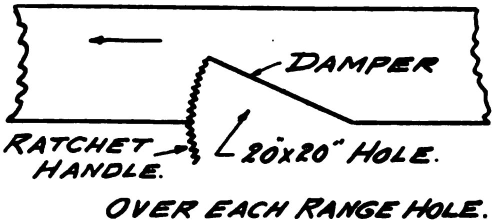


FIG. 3—DETAIL OF RATCHET DAMPER PLACED IN EXHAUST DUCT OVER EACH RANGE HOLE.

is that no branch duct is taken from the main flue without an adjustable volume damper made of No. 22 gauge galvanized sheet iron with indicating quadrants.

Fig. 2. shows a detail of the exhaust duct placed over each range, soup and straining kettle and at suitable intervals there is placed, as shown in Fig. 1, a ratchet damper, which is shown in detail in Fig 3.

In front of the kitchen ranges throughout the hotel and other heat-giving appliances, there is provided a 12-in. fresh air supply, with an adjustable swivel joint connection made of Russia iron with end flare and damper with set screws. A detail of this attachment is shown in Fig. 4.

All the fresh air, before being delivered to the kitchen, is washed by an

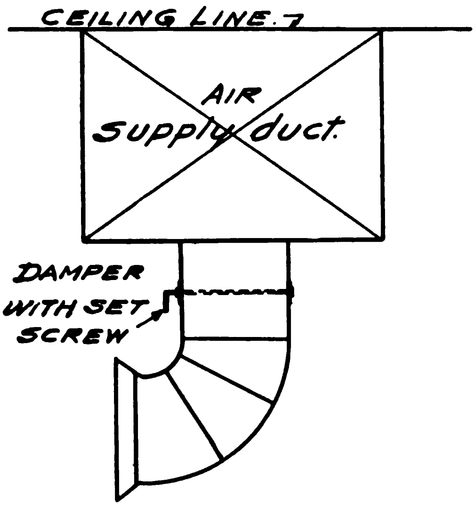


FIG. 4—ADJUSTABLE SWIVEL ELBOW IN FRESH AIR SUPPLY PIPE, PLACED IN FRONT OF KITCHEN RANGES THROUGHOUT HOTEL.

Acme washer, which is designed to remove at least 99 per cent. of all atmospheric contents not gaseous or aqueous. The amount of water used is approximately 1 lb. for every 50 cu. ft. of air passing through the washer at a velocity not more than 450 ft. per minute.

The fans furnished for the ventilating were of American Blower Company make.

The general contractor for this hotel was the George A. Fuller Company, of New York, while the entire kitchen equipment of the Biltmore was planned and installed by Walter J. Buzzini, Inc.

Systems for the Engineer and Contractor

PRACTICAL SUGGESTIONS, WITH FORMS, FOR INCREASING BUSINESS EFFICIENCY

By THOMAS BARWICK, C.E.

(Concluded from December issue)

USE OF DUPLICATING REGISTERS IN KEEPING CONTRACT COSTS.

In the keeping of contract costs there can be some reform from the methods usually followed and if the duplicating registers are used the matter will be further simplified by posting direct from them the cost value instead of the items themselves, thus saving time and considerable annoyance.

In the same way the sheet shown in Fig. 10 could be used as a verified charge sheet where used as such to verify invoices for materials sent directly to the job, instead of charging them from the shop order or the invoice with the order number. In some cases, this will avoid duplication and the charging of more material than is actually received. Items of specialties can be charged direct to the contract book from the invoices when checked by the checking slips.

FORM FOR GROUPING ITEMS OF A CONTRACT.

The method of grouping items of a contract in the charge book is of importance, especially in estimating on future work. In this grouping a suggestion may be made and forms are submitted that will appeal to many as being simple and yet covering items that interest the contractor. There are two leaves covering the various items, one A and one B, as shown in Fig. 11. In these forms, both will be required for a contract. Form A will only require one sheet in most cases, while form B will be required in duplicate or more, as the period of the work requires. In the arrangement as shown the matter is condensed as much as possible. Items which are usually sublet and miscellaneous work, such as painting, trucking, oils, etc., are placed in the proper column and can be totaled as sundries when not otherwise arranged for in the divisions.

The sheets should be ruled and indexed as shown on both sides. They will, therefore, not be cumbersome, and as the most interesting items are noted at the top of the page, such as the articles, etc., with the amount allowed in the estimate for such articles, it is easy to make calculations as to where the contract stands at all times and especially in asking for payments on account.

The form as shown would be operated as follows: The weekly labor account would state in the first column on form B the date and the word "labor," and the amount paid would appear under the "labor" column. If any expenses were incurred, that item would be stated in the first column as "expense men," and the amount placed in the column under "remarks." The same course would be followed with any materials, such as pipe. If taken from stock, for instance, the cost would be made up on the slip from the duplicating machine, with a file number, and this number would be posted under column F for identification and the cost placed under "pipe," and so on. The posting of accounts in the ledger for further identification would appear in

LEDGER NO.________ PAGE INDEX NO.____

CONTRACT CHARGE FOR ________________________

STARTED__________ JOB NO.________ FINISHED ________

SUNDRIES				ALLOWANCES							
PURCHASED	L.	O.	F.	BOILERS & CASTINGS	MASON WK. CARPTR WK.	TANKS & PUMPS	ENGINES MOTORS	BLOWERS FANS	SPECIAL-ITIES	MISC.	REMARKS
CARRY FORWARD											

FIG. 11A—FORM A FOR GROUPING ITEMS OF A CONTRACT.

PAGE INDEX ——

LEDGER NO. ________

CONTRACT CHARGE FOR ______________________________

STARTED ________ JOB NO. ________ FINISHED ______

SUNDRIES						ALLOWANCES IN ESTIMATE						
PURCHASED	L.	O.	F.	PIPE		FITTINGS	VALVES	RADIATORS	COILS	LABOR	GALV. IRON	REMARKS

CARRY FORWARD

FIG. 11B—FORM B FOR GROUPING ITEMS OF A CONTRACT.

column L or, if the amount was charged from the order slip, the order number would be placed under column O.

Likewise on form A, the items charged from invoice would be charged under ledger account L, and the checking slip would show the number in column F.

If any remarks are to be made they can be placed in the "remarks" column. This applies to cartage on boiler, freight, etc., and, as the items are not numerous, they can be quickly totaled.

The form B could be cut, as shown at the top, so that the general job index would be seen on the page of form A, while the B sheets would have subsidiary additions, such as "a," "b," etc. With the above forms the keeping of the records is considerably simplified and a record made of the state of the work at all times, with reference index for verification.

COMBINATION PAY ENVELOPE AND RECEIPT.

The payment of the men is another consideration that should be entered in such a manner that verification is possible, especially where the payments are made on account of work done as extra work. This can be handled in conjunction with the time-cards shown in Fig. 7 to verify the acceptance of payment by the workmen. A suggested pay envelope is shown in Fig. 12 which, when filled out, can be filed for future ref-

No. 177A
PAY ENVELOPE
Tear off annexed receipt and give to Paymaster. Keep this CHECK in case of error

No. 177A DATE_________
VAN PUSHER HEATING CO.
9 WATER ST. CORNERSTONE, IND.
WORKMAN_____________
JOB_____ OCCUPATION_____
AMOUNT_____________
RECEIVED PAYMENT__________
This Slip return to office receipted

FIG. 12—COMBINATION PAY ENVELOPE AND RECEIPT.

erence. In the form shown the envelope should have the receipt on the gummed flap so that it may be torn off and signed and then returned to the office. There the signatures should be compared with the time-card and filed.

By numbering all envelopes and receipt stubs, it is possible to rectify any errors or claims and, where payment is made for work other than contract, they will serve as evidence to substantiate invoicing.

SOLICITOR'S OR ENGINEERING CARD.

There is another form which it would be advisable to have in shops where solicitors for work are employed. It is often valuable to a contractor to know

PROJECT________ VALUE____
AT__________________
ARCHITECT_______________
ADDRESS_______________
SOURCE_______ DATE____
CLOSED BY___ EXTR.___ LOST__

DATE	REPORT OF PROGRESS	SIGNED	EXPENS[E]	

FIG. 13—SOLICITORS' OR ENGINEERING CARD.

how much time it has taken to get a contract as well as what time is spent in addition to that of the actual workmen. This could be known as a solicitor's or engineering card. The value of such a record lies in the fact that it gives some idea of the effort spent in getting the work and, at the same time, acts as a ready reference as to the progress of those in charge. It may be continued after the closing of a contract as an

engineering slip, showing the efforts until the job is completed.

These cards are easily filed and do away with the time spent in writing memoranda in pocket books, as the cards can be filed and refiled under dates when the proposition needs attention, all of which will show on the record.

By making the proper markings on such a card, it can be shown that the salesman or solicitor visited the architect and received the information that in about three weeks the architect would be ready. Therefore, the card was placed in rotation for that time in the rotation of other similar cards. If the solicitor secured the plans or a chance to estimate at that time, he would mark on the sheet "received plans," and if it was necessary to turn over the plans to the engineer for estimating, he would so state on the record. He would also give the card to the engineer who would state when he had finished the estimate and returned it to the solicitor. Further progress would be noted on the card until the job was either closed or lost. If closed, it would then be returned to the engineering staff and the record would show the onward progress until the job was completed in that department. If one card did not cover all of the efforts, then in the space shown the number of the extension could be given. Expenses, such as drafting, materials, etc., could be marked on the card and the record complete charged to the job or office account, as might be desired.

The filing of these cards can be done in a small cabinet, with index cards ot some different color, and with weekly or monthly periods for those that are active, while the cards with "lost" or "completed" contract data can be filed with any other data that were used in the operation.

LEGAL FORM OF EXPANSIBLE POCKET FOR FILING DATA.

In filing all data in connection with work to be done, such as estimates, proposals, specifications, plans, and other data, it is best to use the usual legal form of expansible pocket, as plans can be folded, with the exception of the original tracings. These are kept in better shape either flat or in a roll. Prints should be made from the tracings for folding purposes and they will be found much more serviceable if they are folded so that they will open like an accordion, as in that case, the part to be inspected first can be seen without opening the whole sheet. This will save time.

Small things, such as money receipts or slips like those shown in Figs. 7 and 13, may be strung on strings for future reference.

With the system here detailed there should be considerable time saved both in the management and workmanship and a great saving from losses caused by mistakes and misapplication.

The Air We Breathe—A Study of Temperature, Humidity and Dust Content

By Thomas Hubbard, M. D.

A forceful talk on what is often considered a dry subject, in more senses than one, was made by Dr. Thomas Hubbard recently when he spoke before the American Laryngological Association. Some of the more striking portions of Dr. Hubbard's address are reproduced herewith:

Fire was man's first friend—that is, conservation of body-caloric by artificial heat started the evolution of the higher nervous system, but, to carry this logic to an absurd extreme, one cannot say that mental precocity is in direct relation to the ingenuity in inventing and utilizing heating apparatus. Based on this theory the inhabitants of the Northern and Middle States might claim, for instance, that they are at least 10° more progressive than Europeans. Heating

and ventilating contracts in public school buildings specify 70° F. in America, and in England 60° F. They might raise the question as to which temperature-standard favors the more rapid expansion of the intellect. Are we really 10° hotter on the trail of Truth?

It is interesting to follow the gradual change that has taken place in our own country during the past half century in artificial heat standards. In 1820, American text-books gave 50° to 55° F. as the healthful, comfortable temperature of the living room and nursery (and I should add in passing that the natural relative humidity, taking into consideration the methods of heating,—luminous heat and direct radiation, the open fire-place, ovens and the Franklin stove—would probably be about 40%). In 1850, the comfortable temperature was stated to be 62° F. and in the next thirty years it was raised to 72° F. Now should we consider this 17° change (55° to 72°) a triumph of man's increasing dominance over the elements, or are we on the contrary 17° decadent in physical vigor? Our ancestors of two generations ago would have considered 72° the proper temperature for the aged and infirm, but not for youth. This whole record is a commentary on ingenuity in invention and extravagance in burning up natural fuel resources. (The base burner and hot air furnace were invented about 1840.)

Again I must mention humidity in this connection. The moisture in the air of a building at 70° F. (this applies particularly to public school buildings and places of sedentary employment) would naturally be below 25% relative. Therefore, if we were to state that in the period from, say, 1825 to 1875, we reduced the standard of humidity from 40% or 50% relative to 25% or less it would be a more significant fact from the hygienic standpoint than to call attention to the 17° increase in temperature during that period. In other words, we have worshipped a false god of comfort,—Fahrenheit. Rather too mercurial!

NATURAL VENTILATION DIFFICULT WITH LOW INDOOR HUMIDITY.

The difficulties of natural ventilation (that is, by windows, etc.) are immensely increased at 70° with 25% relative humidity standard. Drafts of outside air are unendurable because the velocity of the incoming air is in direct relation to the relative differences in temperature, and further, the contrast in temperature and particularly in humidity is so marked that it produces real discomfort. A stratum of cold humid air (80% relative) of considerable velocity about the lower extremities produces a disturbing local chill and the rest of the body, including the nasal mucosa, is experiencing 70° with 25% relative humidity.

The essential fact, to which all will agree, theoretically and from experience, is that a standard of 70° and higher, with necessarily low relative humidity, makes efficient natural ventilation almost impractical. At a temperature of 65° with humidity 40% to 50% relative, the perception of the drafts of natural (window) ventilation is less. It is not dependent on merely the difference of 5° in temperature. The water vapor in the air of the room is an equalizer of heat radiation. It tempers sudden changes. The figures, 70° with 25% relative humidity and 40° with 80% relative humidity—that is, the room temperature and the inflowing air from an opened window—graphically express the complex disturbance (we may call it shock) of the heat-regulating functions, the same having been made more delicate by being habituated to the hot, dry atmosphere.

WATER VAPOR EXISTS IN AIR NOT PASSIVELY, BUT POSITIVELY.

We should study *humidity* not as a secondary ingredient of the atmosphere, but as an entity. Water vapor exists in the air not passively but positively. The vapor pressure of the air is as definite as barometric pressure. Air does not absorb moisture, but on the contrary its presence in the air in varying quantities is dependent on the relative vapor pressure. In other words, dry air coming in contact with a moist surface becomes more humid because of the natural tendency to equalize vapor pressure and not because the air is hygroscopic in the same sense that is chlorid of calcium. Keep that property clearly in mind, for this constitutes the difficulty in artificial humidification. *There is no natural at-*

traction between air and water vapor. Vapor diffuses more rapidly in a vacuum than in air. The terms "water hunger air," "desiccating air," and even "saturated air" are mere figures of speech but they are convenient and rather indispensable terms in the discussion of this subject and they should not be interpreted literally.

A few figures (not altogether dry ones) will illustrate the difficulties of maintaining a healthful degree of humidity in buildings heated to our present standard. But first a few words concerning *humidity standards.* This is a very broad subject if we attempt to consider it as applied in the industries and public buildings in general. It is better to limit the scope of the discussion to school buildings and dwellings and places of sedentary employment. The mechanical problems involved in the artificial regulation of indoor atmosphere are complex. It is impractical to attempt a perfect imitation of natural conditions.

The consensus of opinion is that 40 to 50% relative humidity is a healthful and practical compromise. As stated, the difficulty of proper humidification arises chiefly from the fact that the temperature standard is inordinately high.

Here are some of the figures: A cubic foot of atmospheric air can hold, at 30° F., 2 gr. of water-vapor. That is, 100% relative humidity. At 70° it can hold about 8 gr. of water-vapor—an increase of about 6 gr. per cubic feet, and at 80° about 11 gr. If we heat air, temperature 30°, having 80% relative humidity (an average condition in cold weather) up to 70° its relative humidity drops to about 20%. The problem presented is to add enough moisture to maintain 50% more or less at 70° F.

A nine-room house, cubic capacity about 30,000 cubic feet—air changed once an hour (about twenty times daily, the minimum rate of change consistent with warming it by indirect radiation) —would require about twenty gallons of water to be added daily to the warmed air. *About a gallon an hour.* A very considerable amount—in fact it would be quite impractical to evaporate this amount by natural methods, such as ordinary evaporating pans on registers and radiators. The evaporating pan heated by small caliber steam coils immersed in the water will impart to the air in the furnace or air ducts a sufficient amount of water-vapor. This apparatus is used in large plants with forced ventilation. The evaporating pan has been successfully adapted to the ordinary hot-air furnace—a large copper pan over the dome, the essential feature being a continuous automatic supply of water by gravitation from a reservoir outside the furnace.

The objections to live steam as the source of humidity are the disagreeable odor and the noise. Its use is limited to large buildings. The humidistat is quite practical and satisfactory in control of the artificial humidifiers, especially the steam injector type. The atomizer type of humidifier is used successfully in certain factories. The air is first dried by freezing and then a definite amount of water is sprayed into the rewarmed air maintaining any desired degree of humidity. But all this is for a visible profit, and health conservation as a commercial asset cannot command such expenditure.

It is evident that the whole problem of moistening the air to the healthful standard is made difficult and in many instances impractical by the unnaturally high temperature standard to which we have drifted. It is the last 10° that makes the trouble, and by the way we may add the fuel expense of heating a building in cold weather from 60° to 70° exceeds the total expense of raising the heat from 20° to 60° F. 60° *to 65° is the "critical point" in heating air. Above that degree* (65° *F.*) *there is positive resistance due, possibly to the low humidity* and the relative cost of heating the aid and maintaining it at 70° and higher increases in a geometrical ratio. It is a strange coincidence that this "critical point" should coincide with the teachings of hygiene and it is also the standard of the greenhouse. One cannot but surmise that there is a fundamental principle which governs both. In other words 65° *is the natural maximum temperature considered from the physical, hygienic or economic standpoint.* These conclusions are worthy of consideration, for ultimately America will awaken to the foolish-

ness of extravagance, especially where there is involved corresponding health deterioration.

WHEN VENTILATION IS OVERDONE.

It may seem exaggeration to assert that ventilation is ever overdone, but I think that a few illustrations will make it evident that in certain instances such is the fact. In hot-air furnace-heated houses and in all indirect heating systems the air of rooms must be displaced by incoming warm air from once to four times or more an hour to get the proper amount of heat. In cold weather the humidity of the warmed air is near 20% relative. This is a sort of dry kiln effect and the more rapid the change of air (the more ventilation) the more effective the desiccation of all material objects in the house. Even the furniture and piano complain.

I would assert boldly that it is less injurious from the health point of view to live in an atmosphere a trifle overcharged with carbonic gas and organic vapor having at the same time a healthful humidity than to live almost continuously, as many do, in air having only 20% or less relative humidity and 70° F. and even higher temperature, however low the percentage of vitiation. *There is such a thing as too much ventilation when the process is one of gradual reduction of humidity to a point far below the health standard.* In other words, excess of carbonic acid gas and organic compounds are not the only constituents which determine the unfitness of the air of habitations.

DUST AND BACTERIA.

Dust and droplets (minute particles of moisture) are the other ingredients of the air which should be considered in this study. The atmospheric dust is as essential to life as is water-vapor. "No dust, no rain" is the axiom. We can consider bacteria and spores as dust in so far as air currents and moisture are concerned. Dust dissemination in the air of the room is determined by drafts and humidity. Desiccation destroys most bacteria rapidly but spores are more resistant. Elaborate and conclusive experiments with factory dust distribution prove that in a moist air (40% to 50% relative) precipitation takes place very promptly. A healthful relative humidity lessens the liability of transmissions of airborne infections even though desiccative sterilization may be somewhat retarded thereby. Certain it is that a very dry air of high temperature, with the constant drafts resulting therefrom, favors rapid distribution of the dust and germs with corresponding danger of transmission of infection.

Moisture-free air is as a rule dust-charged air in that the available dust content is in circulation. Dry, dusty air is one of the irritants that excites coughing. The conclusion is evident. Moistening the air is a useful therapeutic measure.

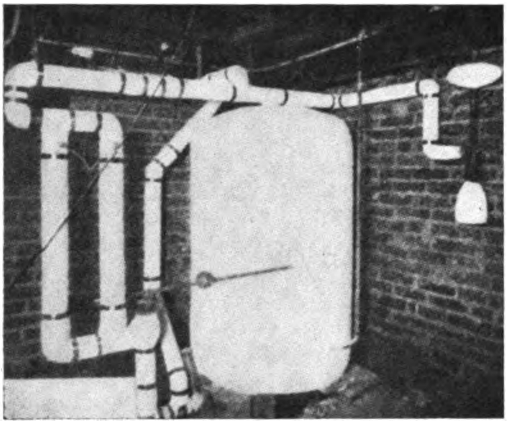
Electric Heating in Seattle

During the past two years several experiments have been carried on by the lighting department of Seattle, of which J. D. Ross is superintendent, to determine the practicability of using electricity for heating the home. For this purpose several houses have been fitted up by their owners with electric heaters, both of the direct radiation type and the type used in connection with hot water radiators. The lighting department connected these houses to its mains, made a special rate for current, and kept complete records of the temperatures maintained in the house and the amount of current used.

The first house equipped is of concrete construction with solid 8½-in. walls, and contains five rooms, having a total floor area of 418 sq. ft., a cubic capacity of 3,252 cu. ft., an outside wall area of 491 sq. ft., and a window area of 127 sq. ft. In this house were installed five electric heaters of the direct radiation type, of which three were 2 K. W. heaters and the other two had capacities of 1½ K. W. respectively. Recording meters were placed in the service to

measure the current; and the daily maximum, average and minimum temperatures, both outside and inside the house, were observed and recorded.

The total consumption for the year amounted to 10,250 K. W. hours, running from 2,430 K. W. hours in December to 20 K. W. hours in July. An average temperature of 70° F. was maintained inside the house, and the minimum at night was kept above 58° F. The mean outside tempe:ature was 51° F. and the minimum, 2(i° F. In this house no discrimination was made with regard to the time of day when the current was used.



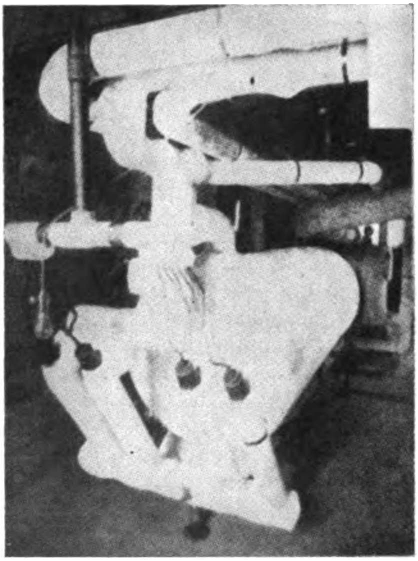
ELECTRIC HEATER FOR SEATTLE RESIDENCE. WITH HOT WATER STORAGE TANK.

Another method of using electric heat is to install an electric hot water heater to replace, or to be used in conjunction with the regular boilers was a hot-water heating system. In theory this method is less efficient than when direct radiating radiators are used, on account of the slight loss in the piping of the hot water system. An advantage which more than offsets this slight loss is that a hot water storage tank may be installed which will supply heat to the house for several hours after the current is turned off, and in this way the supply of current may be cut off during the hours of maximum demand on the lighting plant for current for lighting purposes.

With this scheme of electric heating, enough customers can be supplied with curre-' for heating purposes to exhaust the full capacity of the present distribution system without any further installation whatever except for the mere service wires from the pole to the house, since the heaters will be cut off during the hours when light is used.

There are now four houses equipped with the hot water system of electric heating on the city's lines. Experience shows that one kilowatt of heater capacity will supply 20 sq. ft. of radiation and will require 20 gals. of storage tank capacity to supply heat during the lighting peak in winter.

The cost of making the installation, which is borne by the customer, will run from $10 to $25 per kilowatt capacity of the heater, depending on the size and layout of the house. This expense includes merely the wiring and installation of the electric heater and the cost of the heater itself. The records show that in one house of frame construction having 200 sq. ft. of radiation supplying four rooms with outside wall area of 846 sq. ft. and window area of 201 sq. ft., and cubic contents of 7,290 cu. ft., the monthly consumption of current during the winter months averages 3,000 k. w. hours with a temperature maintained in



ELECTRIC HEATER OF DIRECT RADIATION TYPE INSTALLED IN SEATTLE RESIDENCE.

the house at 68° to 70°, and the average monthly consumption for the entire year will be about 13,000 k. w. hours.

To sum up the results of all the heating experiments to date: Electrical heating for homes is perfectly feasible and is the most convenient and cleanest method. Despite the fact that heaters of 100% efficiency are used, the amount of current needed makes the expense at present rates several times that for heating with coal. One pound of coal contains as much heat as 3 k. w. hours in electricity, and with coal at $6 per ton and current at 2 cts. per k. w. hour, the coal costs 0.3c. as against 6c. for the current, a ratio of 20 to 1 in favor of the coal. This is partially offset by the fact that all of the heat of the current is utilized, while from 30% to 80% of the heat of the coal is wasted. Compared on a basis of cost, electricity at one-half cent per kilowatt hour is from 25% to 40% higher than coal at $6 per ton. By developing water power in large units and supplying heating during "off-peak" hours, it will probably be possible in the future to supply current at rates that will make its use for heating within the reach of the average income.

District Heating

By S. Morgan Bushnell and Fred B. Orr.

1.—Origin and Development of District Heating.

From the earliest dawn of history, mankind when dwelling in those regions situated outside the tropics, has found it necessary to obtain heat by means of fire. The origin of fire is lost in the mists of antiquity. Whether the first notion of fire was obtained from the blazing volcano, or from a forest fire, supposedly lit by the sun's rays, focussed through a piece of quartz or in some other way it is now impossible to determine.

Almost every country in the world has its myths and legends relating to the origin of fire. The Indians of North America claim that the first fire was started from the hoof of a great buffalo striking the flint-rock of the prairie, while the old Greeks had the legend of Prometheus carrying his lighted torch down to earth from the sun. The ancient savage tribes found that by briskly rubbing two sticks together they could develop the spark which would start a simple campfire.

In the castles of the middle ages great fire-places were constructed on which the logs were piled high on cold frosty evenings, while the members of the household gathered around the open fire. Later stoves were provided for a more economical consumption of coal or wood and, still later, furnaces, from which hot-air pipes were led to various portions of the building. All of these applications of heat were local from their very nature.

The more recent methods of transmitting heat by means of steam and hot-water systems have brought what is thus far the last development in the evolution of heating systems, namely, "District Heating." It is interesting to note that the development of district heating has been very closely related to the development of the central station industry for the distribution of electric light and power; in fact, many have supposed that the development of central heating was a result of the adoption of central lighting and power systems.

While it is true that certain systems of district heating, such as the Yaryan system, have been developed as a part of a system for the economical production of light and power, yet the fact remains that central station heating or district heating antedates the development of central station lighting by a number of years. It is doubtless true that in the early days of steam heating various people have heated more than one building from a single source. However, just as Thomas A. Edison is looked upon as the father of the central lighting station, so in the heating industry there is one man generally named as the pioneer inventor of central station heating, Mr. Birdsill Holly, of Lockport, New York. Mr. Holly's inventive genius found an outlet not only

in devising a practical system of central station heating, but also in the invention of the Silsby steam fire engine, the rotary pump, and last, but not least, the Holly system of direct pressure water supply, which has been used in a great many cities all over the country.

THE BEGINNING OF DISTRICT HEATING.

In 1876 Mr. Holly ran an underground line from a boiler in his residence to a barn at the rear of his property and later connected an adjoining house. In 1877, he constructed his first experimental plant at Lockport, in the State of New York, and a number of residences, stores and offices were successfully heated during the following winter.

The first installation consisted of about three miles of street mains and in 1878 another mile was added to the system. The installation was made in accordance with designs patented by Mr. Holly, his inventions applying particularly to the distribution of heating. It is a fact well known by engineers that with a steam piping system it is necessary to allow for the expansion of piping due to the effect of heat, and up to the time of the Holly system, the only method of allowing for this expansion was by means of elbows in the piping. Mr. Holly designed the first expansion joint for taking care of the expansion and contraction of piping and his method of insulating the piping underground was not so very different from the more approved methods in use today.

At the time this system of heating was designed it attracted considerable attention throughout the country and a company was organized known as the Holly Steam Combination Company, Limited. This company acquired Mr. Holly's patents on the apparatus which he designed and also the patent on the system itself. It was not long before heating plants were being established at various points all over the country. An agent of the company would visit a certain town and perhaps call a meeting of some of the representative merchants and bankers of the locality to whom the plan would be unfolded. A company would then be formed and the stock placed with the leading residents of the town. A contract would be let for the installation of pipe line and heating boilers and in a few months another district heating system would be under way.

FORMATION OF AMERICAN DISTRICT STEAM COMPANY.

In 1882 the American District Steam Company was formed and purchased the patent rights of the Holly Steam Combination Co., Ltd., also the other inventions which Mr. Holly had brought out in the previous five years. This company, which, by the way, is considerably older than the General Electric Company, has spent a great deal of time and money in experimenting and in designing central station heating systems, and has contributed in no small degree to the development of this line of business. It is true that a great many of the original plants were financially unsuccessful, just as a majority of the first lighting central stations were unsuccessful; however, in spite of all these discouragements and draw-backs, the men interested in the district heating business have gone steadily on and today the outlook for district heating is brighter than at any period of its history. It is interesting to note that while the first central station for heating was established in 1877, it was not until October 29, 1879, that Thomas A. Edison burned a carbonized piece of cotton sewing thread (in vacuum) for forty hours and demonstrated the possibility of the incandescent lamp. Two years later, after working actively on the various phases of the lighting problem, Edison was able to exhibit at the Paris exposition, a complete system of electric lighting, including the dynamo, wiring and lamps. In 1882, the Pearl Street station of the New York Edison Company was begun, this being the first central station of any importance for the production and manufacture of electricity for lighting purposes.

Turning now to the subject of district heating in New York, we find that this was started several years previous. In the winter of 1879-80, Mr. Cassius C. Peck went to New York and assisted Mr. Wallace G. Andrews, of Cleveland, Ohio, in securing a franchise for the New York Steam Company. The following year this company was consolidated with another company which did not have a franchise, the pipes were laid and the first customer was a printing establishment to

which heat was supplied in May, 1882. It was not until 1883 that steam was supplied to customers in considerable quantities. From that time on, the business grew rapidly from year to year and, as a result, the New York Steam Company has always been the largest and most important company in the country and probably in the world for the distribution and sale of steam.

FIRST DISTRICT HEATING PLANTS USED LIVE STEAM.

In connection with early history of district heating, it should be noted that the first steam heating plants used a direct steam heating system or live steam instead of exhaust steam from a power plant. In fact, probably the first electric company that became interested to any extent in central station heating was the Brush Swan Electric Light Company, of Albany, New York, which installed, in 1885, a direct steam heating plant. However, another proof of Mr. Holly's far-sighted grasp of the situation is shown in the application for a patent, made out April 18, 1881, by Mr. Holly, covering in detail various methods of exhaust heating in use today and including the combination of direct low pressure steam from boilers with exhaust steam from engines, and high pressure feeders where desired from the same system of boilers. This patent, which covers a most comprehensive and general theory of exhaust steam heating, was issued to Mr. Holly, June 27, 1882. For several years, the value of this patent seems to have been only partially appreciated and it was not until 1889 that any considerable system was installed, based on the use of exhaust steam.

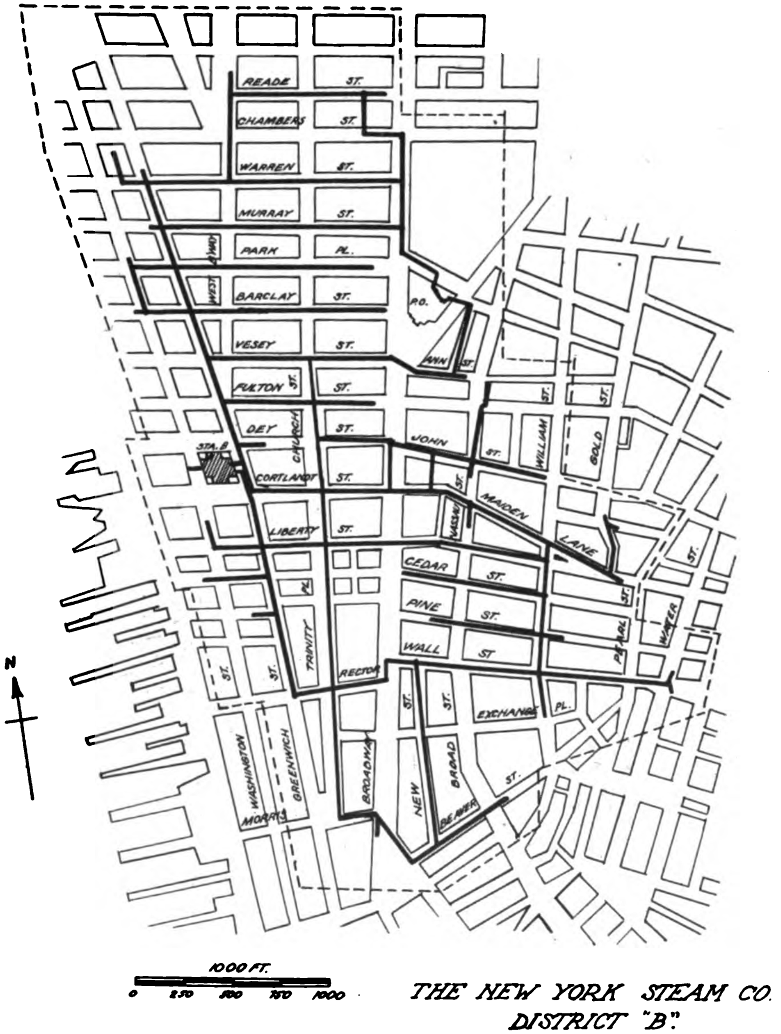
BIRDSILL HOLLY, OF LOCKPORT, N. Y.
"Father" of the Central Station Heating Industry.

In December, 1889, a system was installed by the Ottumwa Railway & Light Company in the city of Ottumwa, Iowa, consisting of nearly 6,000 ft. of mains. This system was designed for the purpose of heating from house to house by

means of exhaust steam. The fact that as far back as 1878 direct steam heating systems were installed in Albany, N. Y., Springfield, Mass., and Detroit, Mich., shows that it was fully ten years after the first general knowledge of district heating that exhaust steam systems were adopted.

In Detroit the heating business has been gradually extended and was for years conducted by two companies, the Edison Illuminating Company, of Detroit, and the Murphy Power Company. In the spring of 1914, a consolidation of the two companies was effected giving the Edison Illuminating Company of Detroit a total heating business of about 1,500 customers.

The Central Heating Company of Milwaukee is another company which has gone into the business of central heating on a very extensive scale, and with marked success. In the city of Indianapolis, there is a large amount of heating business. There were formerly three companies furnishing district heating, the Merchants' Heat and Light Company, the Indianapolis Light and Heat Company and the Home Heat and Light Company. The first two distributed heat by means of exhaust steam from the engines of their electric lighting stations, while the last used a hot-water system; the water for this system being largely heated by exhaust steam. Recently the plant of the Home Heat and Light Com-

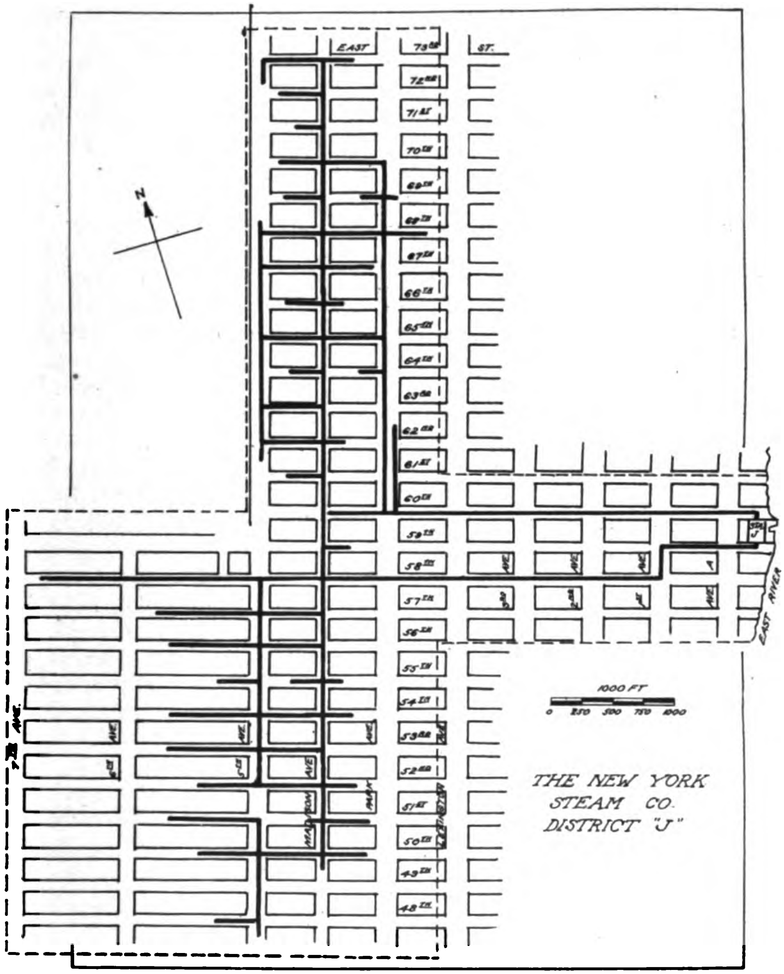


DOWNTOWN HEATING SYSTEM OF THE NEW YORK STEAM COMPANY.

pany was bought up by the Merchants' Heat & Light Company, leaving at present two companies in the field.

SMALLER TOWNS TAKE UP DISTRICT HEATING.

District heating plants are not only in the larger cities, but also in a great many of the smaller towns throughout the country. It has been found most satisfactory and economical, for a great many colleges and various institutions having a number of buildings, to have one central heating plant to supply all the various buildings. On the Long farm near Kansas City, there are about two miles of heating mains, connecting various barns, houses for the employees, and the owner's residence. Some of the finest blooded horses are kept on this farm and by distributing heat in this way to the different barns, the danger of fire is eliminated. Ball Brothers, of Muncie, Ind., occupy seven houses connected with a system of mains about one-half mile in length, the central heating plant being located on a switch track, thus reducing the cost of fuel. However, it is unnecessary to enumerate the many cities and towns all over the country in which district heating has been adopted as a matter of convenience and economy.



UPTOWN HEATING SYSTEM OF THE NEW YORK STEAM COMPANY.

DEVELOPMENT OF COMPANIES FORMED TO OPERATE EXISTING PLANTS.

Up to the year 1900, the development of district heating was based on furnishing the service from one main central

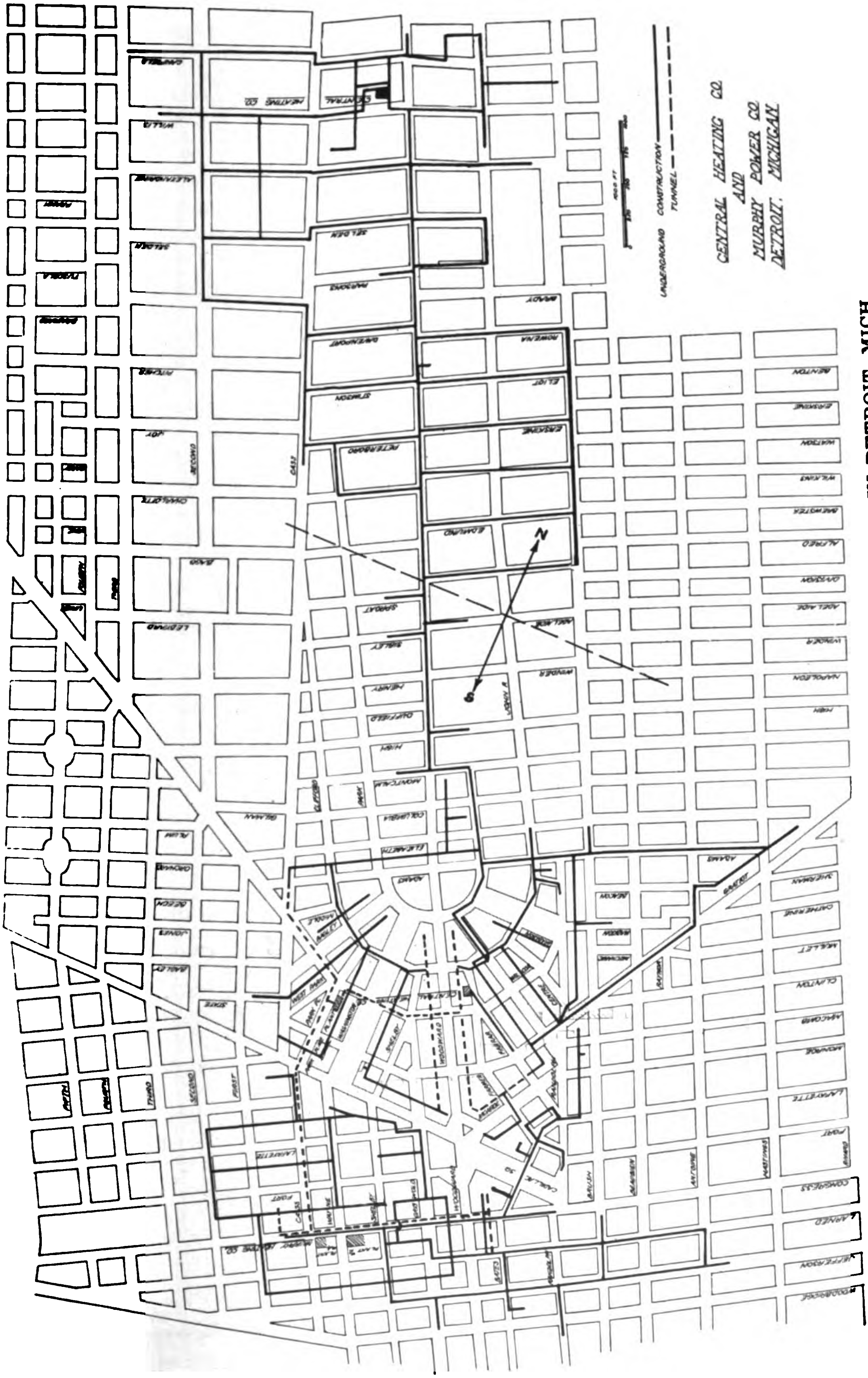
source of supply, using a system of distributing pipes running through the streets. About that time, there commenced a development of district heating along slightly different lines. Most of the large electric light and power stations began to feel a demand from their larger customers for a company that would complete the cycle of their requirements and enable building owners to contract for the three forms of energy required for the operation of a building, viz.: light heat and mechanical power. In order to supply this want, and at the same time to avoid the enormous expense connected with the installation of steam pipes in the congested districts of a large city, a company was organized in Chicago in 1900, known as the Illinois Maintenance Company.

The charter of this company was a broad one, but the main object of the company has always been to operate heating plants. The company was operating on a scheme somewhat diverse from that employed by steam heating companies up to that time. It installed no plants of its own, and, except in one or two cases, installed no boilers. Its plan was simply to contract to operate boiler plants already installed in buildings so as to furnish steam and heat for the building and for other buildings. This scheme at first sight may seem a radical departure, and it might be thought that central station heating was being lost sight of, but a careful study of the situation will prove the reverse to be true.

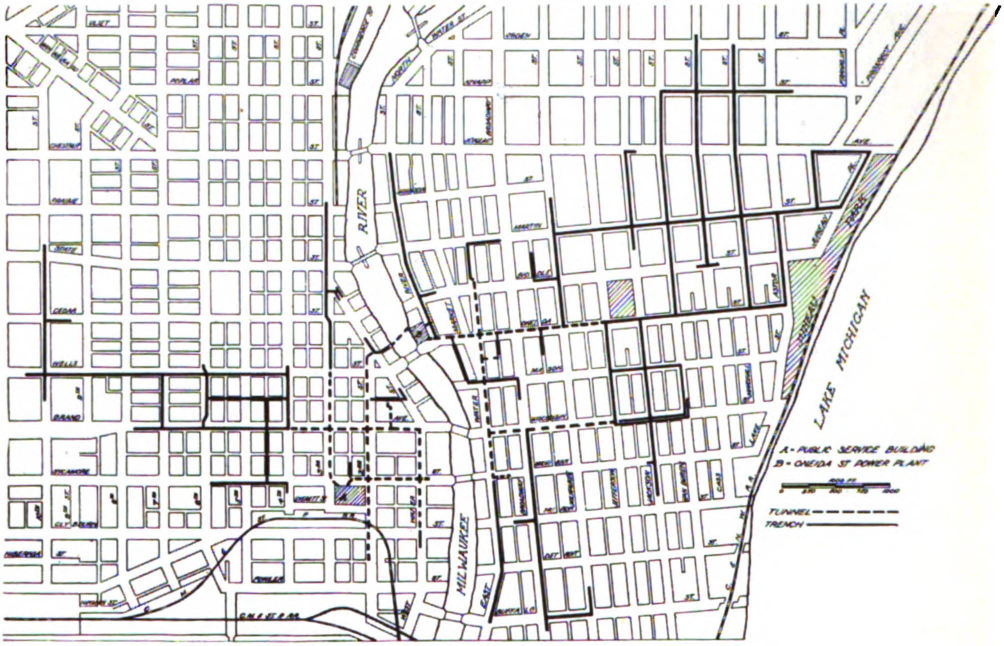
In the first place, the conditions to be met with in a large city are radically different from those in small towns, having a house to house business, and also having the advantage of a marked difference in economy between the small heating boiler used in houses and the large one of 300 to 500 h.p. found in the central station. Careful tests which have been made on residence boilers under test conditions show an average efficiency of 40 to 50%. It is probable that under ordinary working conditions the percentage might even be less, perhaps 35%. The large boilers used in central stations will give an efficiency of between 70 and 80%. If we would assume an average efficiency on the large boilers of 65% we would have right there a difference of nearly 50% between the coal consumption for the same amount of heat in the smaller boiler and that required with the large boiler. Furthermore, the small house heating boiler uses anthracite coal which costs fully 100% more than the soft coal used in the larger boiler installations. Accordingly, if it were not for transmission losses, a central heating plant could supply a given amount of heat with about one-fourth the coal cost of a small house heating boiler.

In the center of large cities like New York and Chicago, this difference disappears, as the ordinary business block will require from 100 to 500 h.p. in boiler capacity and the difference in efficiency between the 100 and 500 h.p. boiler is comparatively small. On the other hand, the difficulty of installing elaborate systems of street mains in city streets, already crowded and congested with the pipes of various other utilities, is almost insuperable. Accordingly the Chicago company adopted a consistent plan of operation which used boilers already installed in buildings and also connected by pipe lines adjacent buildings in order to gain economy by shutting down the small plants and operating only the large ones. This, to be sure, requires occasional crossing of streets, but does not require anything like the expense which would be involved in a comprehensive system.

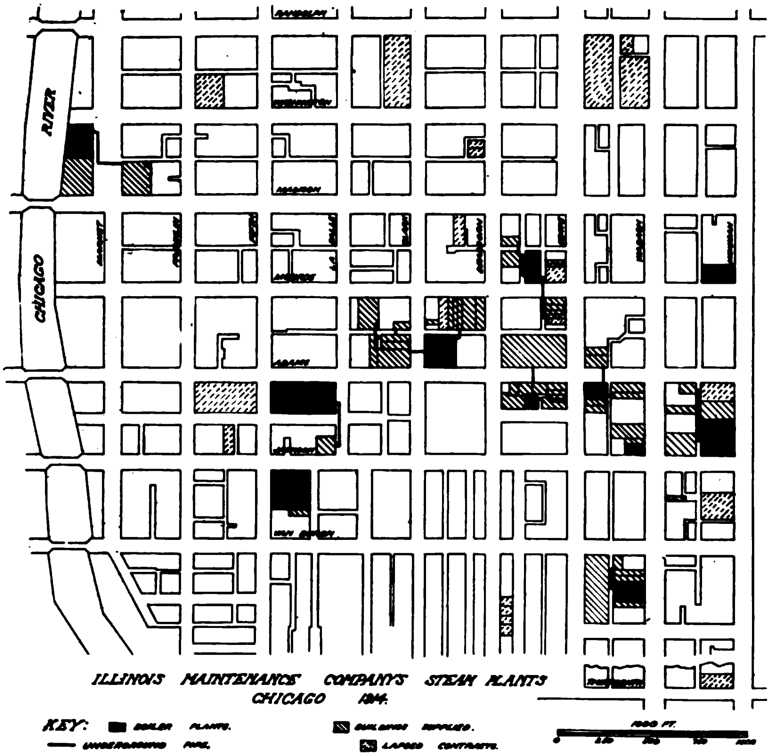
Soon after this system was started, the Boston Edison Company inaugurated in Boston a similar system, operated under the direct management of the company. A little later the New York Service Company was organized and operates to a limited extent in the business district of New York. In Philadelphia and St. Louis a similar scheme has been worked out to a certain extent. While in all of these different cities, there are individual characteristics and slight variations from the general plan, the net result has been a rapid increase in the field of district heating. In New York City the New York Steam Company has improved its load factor by using its battery of boilers for the manufacture of ice in the summer time. In other words, the same generating plant that produces power for heat in the winter time, when heat is required, produces cold in the summer time when cooling effect is to be obtained. Other



MAP OF THE TWO SYSTEMS OF HEATING MAINS IN DETROIT, MICH.



MILWAUKEE'S DISTRICT HEATING SYSTEM.



ILLINOIS MAINTENANCE COMPANY'S STEAM PLANTS IN THE LOOP DISTRICT OF CHICAGO.

cities obtain a certain degree of economy by utilizing the exhaust steam from central lighting stations. The steam is used either for heating water used in hot-water systems or for circulating at low pressure through systems of steam piping.

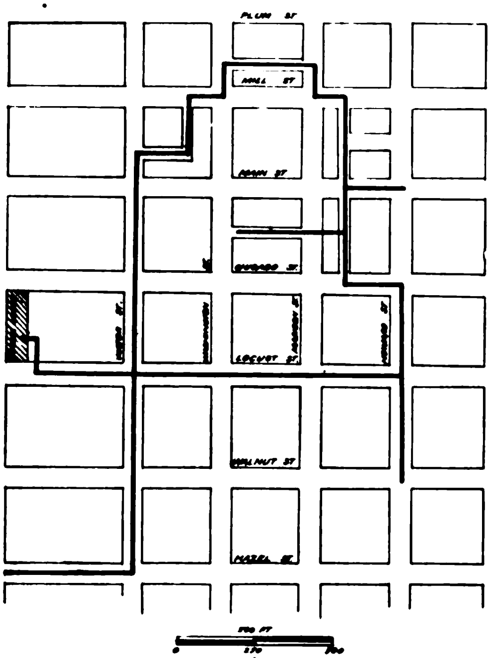
ORGANIZATION OF NATIONAL DISTRICT HEATING ASSOCIATION.

As district heating has become more and more widely used, various suggestions for economical operation have been brought forward from time to time and the engineering fraternity has grown to realize that in district heating lies a fruitful field for obtaining economies through scientific construction and management. It was in view of this situation that the need of a national association of district heating companies became more and more apparent, and this idea finally crystalized in an after meeting of the Ohio Electric Light Association, July 15, 1909. At that time a temporary organization was formed and arrangements were made for a convention which was held November 10, 1909, in the Great Southern Hotel, Columbus, O.

Since that time the National District Heating Association has held conventions each year during the latter part of May or the first week in June and the association has grown from a small group of about a half-dozen men in 1909, to a membership in 1914 of about 300, including most of the heating companies in the United States, several from Canada, and also members from Germany, France, England and Russia. The objects of the association have been to promote the interests of its members in all matters relating either to steam or hot-water heating, with special reference to district heating; also to establish helpful relations with kindred associations and with manufacturers of heating equipment. The association is the outgrowth of an effort to bring the business of district heating to a practical and scientific basis and provide a general distribution of knowledge concerning the important facts connected with district heating.

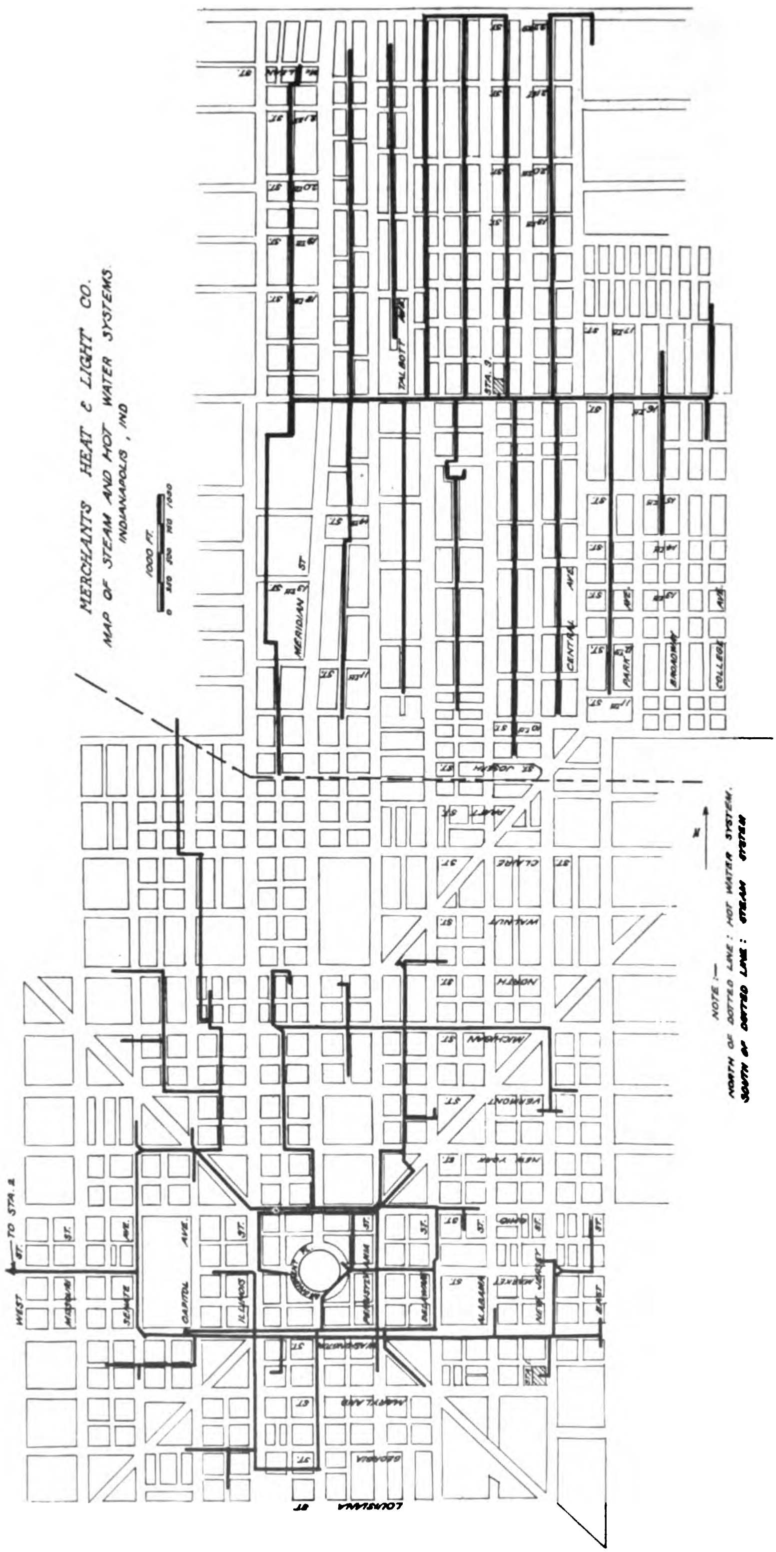
That the art or business of central heating has made marked progress is shown by the steady improvement in the character of the reports and papers on steam engineering subjects provided at these annual conventions. The association each year publishes bound volumes containing these reports, and their discussions, and they constitute at the present time the most complete and authentic information on the subject of district heating that has thus far been published.

While like many other associations of similar character it has passed through certain periods of discouragement, it is rapidly growing to be one of the most influential technical associations in the country, and the marked spirit of loyalty and enthusiasm that pervades the association is due not only to the pleasant acquaintances and friendships formed among the members, but also to the con-



UNDERGROUND SYSTEM OF STEAM MAINS IN PONTIAC, ILL.

fident belief that the business of district heating has passed through its days of discouragement and that the future is laden with tremendous possibilties in the development and expansion of the industry. Already there are now between 300 and 400 heating companies in the United States representing an investment of many millions of dollars. This development, in the opinion of many of those most familiar with the subject, is merely the beginning of a great industry which



STEAM AND HOT WATER SYSTEMS OF THE MERCHANTS' HEAT & LIGHT COMPANY, INDIANAPOLIS, IND.

will have a very important influence on future civilization not only in this country but also in other countries.

TYPICAL DISTRICT HEATING SYSTEMS.

Attention is called to the maps given herewith, which show in graphic form the extent of the heating business in some of the principal towns in the country. The map showing the heating mains in the city of New York includes two systems, one the downtown system in the heart of the business district, the other the uptown system, supplying residences and moderate-sized business establishments. In September, 1914, the service supplied from these mains included 1,300 customers to whom were furnished 1,750,000,000 lbs. of steam per annum, from which the company received a yearly income of $933,000. The pipe used for these mains varies in size from 6 in. to 24 in. in diameter, and their aggregate lengths is about 73,000 ft.

The accompanying map showing the heating systems in Detroit, indicates two systems of mains totaling in length about 100,000 ft., supplying about 1,500 customers with a total of 1,500,000 sq. ft. of radiation. The accompanying map of the heating systems in Milwaukee shows a system of mains having a total length of about 60,000 ft., to which is already connected a half-million square feet of radiation. The accompanying map of the loop district of Chicago shows the extent of their sectional heating system. There are already about 800,000 sq. ft. of radiation connected, and if the additional steam for laundries, kitchens, elevator pumps, etc., is included, the steam load is equivalent to about 1,200,000 sq. ft. of radiation.

While the heating systems of the larger cities may be of special interest, yet the importance of district heating in the smaller cities and towns should not be overlooked. The accompanying map of the underground system of mains in the village of Pontiac, Ill., shows a steam heating system for heating residences and small stores comprising about 6,400 lin. ft. of underground pipe line. This system, which supplies 119 customers having about 80,000 sq. ft. of radiation connected is typical of a large number of small plants which, while individually somewhat limited in extent, form the separate links in an ever increasing chain of district heating systems scattered throughout the country.

The map showing the heating mains of the Merchants' Heat & Light Co. of Indianapolis, Ind., is interesting on account of the fact that it shows not only a steam heating system in the downtown district, fed from two boiler plants on opposite sides of the city, but also a hot water system supplied from a single plant in the residence district. The hot water system consists of about 52,000 lin. ft. of underground pipe line, and supplies about 300,000 sq. ft. of hot water radiation. The steam heating system consists of about 43,000 lin. ft. of underground pipe lines and supplies about 900,000 sq. ft. of radiation.

The foregoing are merely a few examples taken at random, and include only a fraction of the large and important steam heating systems already installed. The examples given, however, are probably sufficient to show that the business of district heating is rapidly becoming a large and important factor in municipal life, and is a business which has come to stay. In view of this fact, it may be interesting to take up in succeeding articles some of the points of practical information required in the successful operation of a steam heating company.

(To Be Continued.)

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ONE of the moot questions in the heating trade during recent years is the comparative value of live and exhaust steam as a heating medium. The discussion, as we recall it, arose in the first place through the appearance of an advertisement in which the claim was broadly made that "exhaust steam is better than live steam for heating purposes." One of the causes of this was stated to be that exhaust steam will give up its heat faster to the radiating surface than live steam from a reducing valve, as, in the latter case, the steam is in a superheated condition.

The statement as quoted formed the basis for an extended discussion before the heating engineers' society in which a number of speakers testified to its correctness, based upon their own experience, without being able to give a sufficient reason for it. It was claimed, for instance, that certain buildings, satisfactorily heated during the day time, when the engines were running, could not be heated with live steam at night, and in many cases the engines were kept running all night to furnish a supply of exhaust steam. This, moreover, was accomplished without increasing the coal consumption.

More recently the apparent difference has been explained on the basis of the kinetic energy of the steam; that is, that exhaust steam enters the piping in puffs and achieves a better circulation, due to the pulsations of the engine.

On the other hand, more than one keen observer has maintained with confidence that there is no difference between the relative efficiency of live and exhaust steam under otherwise the same conditions.

In view of these conflicting opinions it is a pleasure to be able to present in this issue the first careful mathematical analysis we have seen of a matter that has been shrouded in more mystery than apparently it has merited.

As a result of the analysis the statement is confidently made that "there is absolutely no difference in the physical properties of steam after passing through an engine and in leaving the boiler," and that "there is actually no difference in the use of exhaust and live steam for heating purposes, provided they are under the same conditions as to quality, pressure and temperature." Moreover, the further statement is made that either live or exhaust steam may have the advantage as to its heating quality, depending on its condition.

The writer wisely advises that engineers should cease to make use of the terms "exhaust" and "live" steam, when they are differentiating between the two, and confine themselves to the terms of "quality," "temperature" and "pressure" in either case.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

Does it Take a Greater Amount of Heat Initially to Heat With Live Steam Than With Exhaust Steam?

In the November number of THE HEATING AND VENTILATING MAGAZINE appeared an excerpt of the discussion before the New York Chapter of the American Society of Heating and Ventilating Engineers. This excerpt is very interesting to me, particularly page 53, left-hand column. In the first paragraph is an account of the experience of Mr. Kimball with live and exhaust steam on a heating system.

We have experienced this same thing with our district steam heating system and have done considerable wondering about it without having arrived at a satisfactory solution of the problem.

Considering Mr. Kimball's case, the question arises as to whether the service given after the two engines had been put on was as good as it was with the straight live steam; that is, were the radiators as hot after the engines were started as they were before? From our experience here, there is no qustion but that the difficulties at the plant in keeping up steam are relieved by adding another engine to the line.

I believe that practically everyone concedes that exhaust steam is a better heating medium than straight live steam, as far as service, and the ability of the steam to enter air-pocketed and water-pocketed lines is concerned. We have never had a complaint registered on a change from live to exhaust steam. For a time, we thought the service was equally good, but a consideration of the engineering conditions of the problem has forced us to the conclusion that the service is not as good, but that it is not enough less satisfactory to call for complaints from customers. They do not even notice the change.

We furnish a considerable amount of live steam to our heating system, due to the fact that we are not located in a factory community. There were days last December and January, with the mercury down as low as —35° F., when we had to supply live steam for 24 hours per day. The question came up as to whether it would not be good practice to make power rates low enough to attract certain loads that we are unable to get with our present rates. The exhaust steam from this class of day load would give us enough steam for our heating system and would obviate the use of live steam with its attendant coal costs.

With exhaust steam, customers are getting as many heat units as they would get from their own boilers, assuming a similar pressure in both cases. But, as superheated steam is supplied, customers' meter readings are not in proportion to the heat units supplied, the ratio of weight of steam to heat units decreasing as the degree of superheat is increased. Thus, we figured that a low rate for power for off-peak use only was justifiable.

I have tried to work out the saving in steam effected, or rather the increase in steam which would be necessitated by the supply of exhaust steam only. The result, an increase of 2.5%, does not seem large enough, particularly in comparison with the apparent decrease in drag on the boiler when engines are started. Even then, this 2.5% is based on the assumption that 250° steam is supplied during the entire 24 hours, which is not the fact, as the enclosed temperature chart will show.

There is apparently an error in my computation.

Increase in Steam Delivered to Customers by Supplying Exhaust Steam Only.

Atmospheric pressure at 7,159 ft. altitude $=$ $7{,}159 - 5{,}280 = 1{,}879$ ft. $= 1\ 1879/5280$ miles.

1 mile $= 12.02$ lbs. pressure per square inch. 2 miles $= 9.8$ lbs. pressure per square inch. $12.02 - 9.8 = 2.22$ lbs. difference.

$(1{,}879 \div 5{,}280) \times 2.22 = 0.79$ lbs. per square inch. $12.02 - 0.79 = 11.23$ lbs. per square inch $=$ actual pressure at Laramie.

Holding maximum pressure of 3.5 lbs. gauge $= 11.23 + 3.5 = 14.73$ lbs. per square inch atmospheric pressure. 14.73 lbs. $= 1{,}146$ B. T. U. per pound steam.

250° F. = temperature of superheated steam. 250 — 212 = 38 superheat. 0.4805 = specific heat of superheated steam. 0.4805 × 38 = 18.259 B. T. U. to add.

1,158.3 = B. T. U. in 250° saturated steam. 1,158.3 + 1,176.6 = B. T. U. in steam at 3.5 lbs.

1,176.6 — 1,146.6 = 30. 30 ÷ 1,176.6 = 0.025% saving.

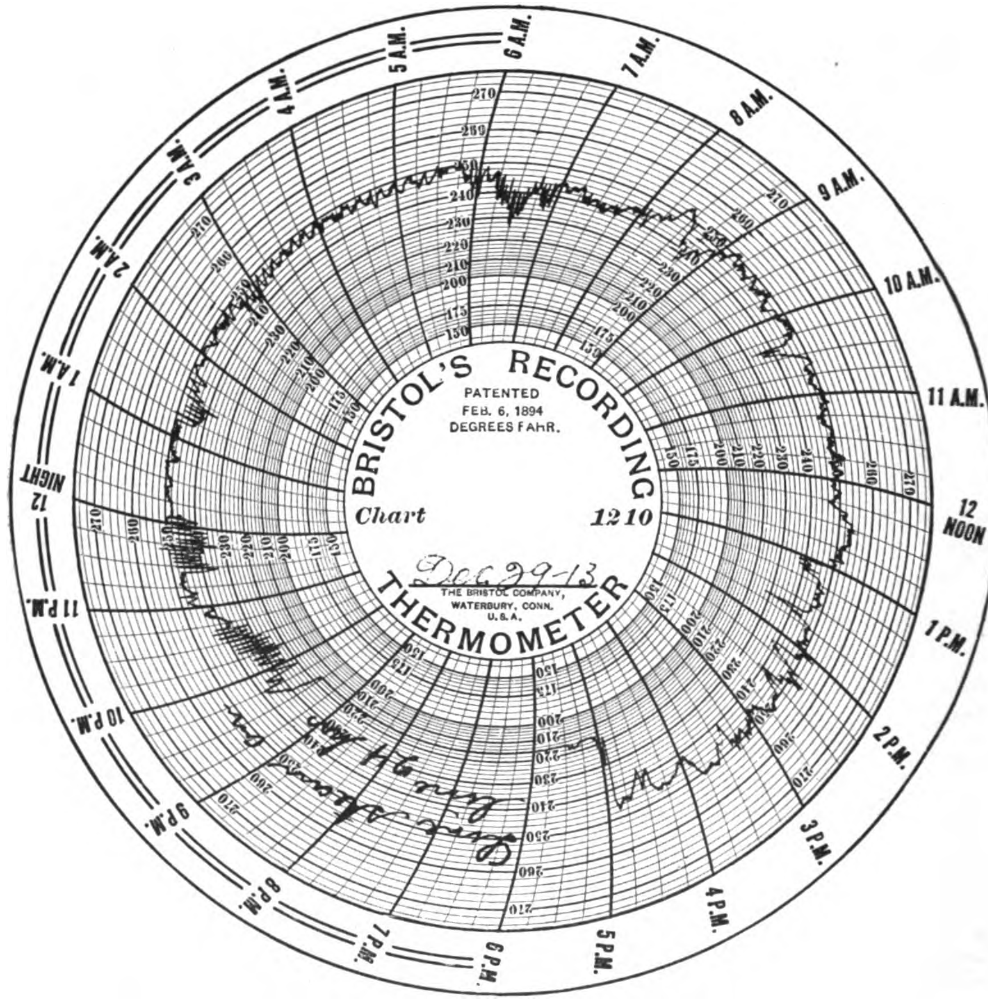
This matter has been put up to a number of engineers passing through here, but they have not been able to locate my error, if any exists.

As a reader of your magazine, I would be very glad to get your views on the matter. It is, I believe, of general interest to every engineer operating under conditions similar to ours.

A. E. ANDERSON.

Laramie, Wyo.

ANSWER: This is a question that is often answered by operating engineers in the affirmative and the claim is made that the operation of the plant will show such to be the case by its action under either condition. Operating engineers are often apt to make such statements without analyzing the conditions and, therefore, sometimes assign an incorrect cause for some physical facts in plant operation.



STEAM TEMPERATURE CHART AT LARAMIE DISTRICT HEATING PLANT.

As little time and less money is appropriated for accurately determining the facts concerning plant operation, it is not surprising that we all more or less differentiate on the properties of exhaust and live steam as if they were two entirely and distinct products.

There is absolutely no difference in the physical properties of steam after passing through an engine and that leaving the boiler. There

is, however, a difference in its condition of pressure, temperature and quality.

Broadly speaking, exactly the same conditions of pressure, temperature and quality may be imposed on either exhaust steam or live steam. However, due to passing through an engine and doing work, the condition is generally one of lower pressure, temperature and quality than when leaving the boiler. By adding heat, however, it can be returned to its former condition of pressure and temperature.

The reason for the above inquiry and statements is occasioned by the general lack of precise expression among good engineers in describing exhaust or live steam as entirely different products.

If the conditions of pressure and quality are given as the same, live steam becomes exactly the same as exhaust steam. In some cases, exhaust steam has oil as a foreign substance from the engine. If not removed, the live steam will contain oil as well, although, perhaps, in not quite so large an amount.

A TYPICAL CASE CONSIDERED.

In answering the above question, a line of 12-in. pipe will be assumed 2,000 ft. long, covered with insulation 85% efficient, and the exact quantity and condition of the steam will be determined mathematically. An effort will also be made to show how a seeming difference in power requirements may occur, due to the heating of the feed water in either case. The condensation from the main line will be assumed as wasted to the sewer, as this is the condition generally met with in central steam plants on district heating. The conditions, it will be noted, are those given by our correspondent in connection with his inquiry.

The plant, he stated, was situated at an elevation of 7,159 ft. As the pressure, at a height of one mile is 12.02 lbs., and, at two miles, 9.8 lbs., and as there are 5,280 ft. in one mile, the proportion will be 12.02 — 9.8 lbs. = 2.22 lbs. × (7159 — 5280) ÷ 5280=0.79 lbs. pressure. 12.02 — 0.79=11.23 lbs. as the atmospheric pressure, approximately. It is stated that the gauge reads 3.5 lbs. and this added to 11.23 gives an absolute pressure of 14.73 lbs. per square inch.

This illustrates a common error in using a Bourdon spring gauge. It registers the same pressure at the sea level as on a mountain. The difference in pressure between the gauge and atmosphere at any elevation will vary, however, with the altitude. This is confirmed by the temperature of the saturated steam of 220° F. The actual pressure between that corresponding to the temperature given and the atmospheric pressure at that altitude is really 17.2 lbs. absolute — 11.2 = 6 lbs., instead of 3.5 lbs.

The initial gauge pressure for both live and exhaust steam is given as 3.5 lbs. and, for live steam, a temperature of 250° F., and, for exhaust steam, 220° F. This means a superheat of about 30° F. on the live steam and saturated steam for the exhaust, nearly. The temperatures show that the initial pressure is not quite 3.5 lbs., as it would mean a temperature of 225° F. We will, however, assume the same pressure in both cases of 17.2 lbs. absolute initial and 11.2 lbs. as the atmospheric pressure or barometer.

The flow of steam will be calculated in both cases for a total drop of 6 lbs. and the efficiency determined with 60° temperature of feed and with 210° F., which would be the case if the feed water were heated by the exhaust steam or not. The first operation will be to determine the radiation losses in the main 12-in. line 2,000 ft. long. The pipe will have 0.33 lineal feet per square foot of surface. The ground will be assumed as at 40° F. and a transmission from bare pipe of 3.5 B. T. U. per square foot per degree difference in temperature per hour.

2,000 ft. pipe ÷ 0.33 = 6,667 sq. ft. surface and 85% efficiency = 1,000 sq. ft. of bare pipe as the equivalent.

1,000 × (209 — 40) × 3.5 B. T. U. = 591,500 B. T. U. per hour saturated steam.

1,000 × (224 — 40) × 3.5 B. T. U. = 644,000 B. T. U. per hour superheated steam.

The loss per second, in each case, will be:

Saturated steam, 591,500 ÷ 3,600 = 164.3 B. T. U., and, for superheated steam, 644,000 ÷ 3,600 = 179 B. T. U.

It is first desired to know the pounds of steam per second that will be discharged in each case, using a trial drop of 6 lbs. To obtain this, we will use Meier's formula as modified in Question 35 (see September, 1914, issue). The constant and exponents have been slightly modified on account of the lower steam pressure in this case.

TABULATION OF INITIAL AND FINAL STEAM CONDITIONS.

	Initial Condition				Average		Final Condition					
	Absol. Press. Lbs.	Temp. Deg. F.	Pounds per . Cu. Ft.	Total Heat Deg. F.	Pounds per Cu. Ft.	Temp. Deg. F.	Pressure Lbs.	Temp. Deg. F.	Pounds per Cu.Ft.	Total Heat Deg.F.	Latent Heat Deg.F.	Heat Liquid Deg.F.
Saturated Steam	17.2	220	0.0432	1153.3	0.03605	209	11.2	198	0.02891	1145.2	979	166
Live Steam, Superheated	17.2	250	0.04143	1167.5	0.03517	224	11.2	198	0.02891	1145.2	979	166

P_f in pounds per square inch $= 1,422.92\ [W^{1.97} \div (K^{0.97} \times D^{5.1})] \times$ length, or 2,000 ft. $=$ friction.

P_v in pounds per square inch $= 3.625\ W^2 \div D^4 K =$ velocity head in pounds per square inch. The trial has already been made by the writer and is here omitted on account of lack of space.

W in pounds for the saturated steam was 5.31 lbs. per second.

W in pounds for the superheated steam was 5.24 lbs. per second.

The velocity head in each case can now be determined by substituting in the P_v formula and the proper discharge determined, with the velocity head deducted.

P_v saturated steam $= 3.625\ (531)^2 \div (12^4 \times K) = 3.625 \times (5.31)^2 \div (20,736 \times 0.03605) = 0.1365$ lbs. per square inch.

P_v for superheated steam $= 3.625\ (5.24)^2 \div (20,736 \times 0.03517) = 0.13703$ lbs. per square inch.

The net discharge for the saturated steam in pounds per second will be: $W^{1.97} = [0.03605^{0.97} \times D^{5.1} \times (6 - 0.1365)] \div (1,422.92 \times 2)$.

Applying logarithms, $W^{1.97} = 5.50382412 - 1.39980159 - 3.1531805 + 0.4671269$.

$W^{1.97} = 1.41786983$; $W = 1.41796893 \div 1.97 = 0.7197812 = 5.246$ lbs. per second for saturated steam.

The net discharge for the superheated steam will be:

$W^{1.97} = [(0.03517)^{0.97} \times 12^{5.1} \times (6 - 0.137)] \div (1,422.92 \times 2)$.

$W^{1.97} = 5.50382412 - 1.41021277 - 3.15318050 + 0.4670809$.

$W = 1.40752075 \div 1.97 = 0.7144268 = 5.1812$ lbs. per second for superheated steam.

The loss in pounds per second in condensation for the mains, due to radiation losses, will be, for saturated steam:

$164.3 \div (5.25 \times 979$ B. T. U.$) = 0.32$ lbs. per second per pound delivered.

0.032×5.246 lbs $= 0.168$ lbs. steam condensed due to radiation from main. As there is one-half the condensation before the center of the line is reached, only one-half is deducted from the flow. The net discharge for use at the end of the line will be 5.246 lbs. $- [(0.032 \div 2) \times 5.246] = 5.162$ lbs. per second as the net discharge for saturated steam at 11.2 lbs. absolute for use.

For the superheated steam the loss per second will be 179 B. T. U. and as the steam is superheated the loss in condensation will be reduced. $179 \div 5.2 = 34.5$ B. T. U. per pound per second.

$1,167.5 - 34.5 = 1,133$ B. T. U. per pound, which is below the total heat at the final pressure and temperature, which is 1,145.2 B. T. U.

$1,145.2 - 1,133 = 12.2$ B. T. U. condensed. Taking the condensation as one-half as before, $6.1 \div 979 = 0.0062$ lbs. per second per pound of steam delivered.

$0.0124 \times 5.2 = 0.06448$ lbs. steam condensed to water per second.

$5.1812 - (0.06448 \div 2) = 5.149$ lbs. net delivered at the end of the main for heating at 11.2 lbs. absolute for superheated steam.

The initial weight will be the net weight at the end of the line plus that due to radiation and condensation. For the saturated steam the initial quantity will be $5.162 + 0.1680 = 5.33$ lbs. per second. For the superheated steam the weight delivered will be initially $5.149 + 0.0645 = 5.2135$ lbs. per second.

The total condensation leaving the mains to the sewer in each case will be, for the saturated steam, $0.1682 \times 3,600 = 605.52$ lbs. water per hour, and, for the superheated steam, $0.645 \times 3,600 = 232.13$ lbs. per hour. $605 \div 232 = 260.8\%$, or the saturated steam involves 160.8% greater condensation of water than the superheated steam.

The net heat in B. T. U. per second delivered, with the saturated steam, will be 979.2 B. T. U. (latent heat) at 11.2 lbs. absolute. 5.162×979.2 B. T. U. $= 5,054.63$ B. T. U. per second, saturated steam. 5.149×979.2 B. T. U. $= 5,041.9$ B. T. U. per second superheated steam. This shows a very slight advantage of about ½ or 1% in favor of saturated steam.

The heat supplied in each case to obtain the delivery will be as follows, if the feed water temperature was 210° F., with 178 B. T. U. in the liquid:

For the saturated steam, $5.33 \times (1,153.3 - 178) = 5,198.35$ B. T. U. per second. For the superheated steam, $5.2135 \times (1,167.5 - 178) = 5,158.76$ B. T. U. per second.

With 60° feed and 28 B. T. U. in the liquid, the heat supplied will be, for saturated steam, $5.33 \times (1,153.3 - 28) = 5,997.84$ B. T. U. per second, and, for superheated steam, $5.2135 \times (1,167.5 - 28) = 5,940.8$ B. T. U. per second.

The relative efficiency of the superheated steam over saturated steam under the two feed conditions as named, which would represent fairly the use of exhaust steam against the use of live steam, will be as follows:

Saturated steam, feed 210° F. $5,054.63 \div 5,198.4 = 97.23\%$.

Superheated steam, feed 210° F. $5,041.9 \div 5,158.76 = 97.73\%$.

Saturated steam, feed 60° F. $5,054.63 \div 5,997.84 = 84.27\%$.

Superheated steam, feed 60° F. $5,041.9 \div 5,940.8 = 84.87\%$.

NO DIFFERENCE UNDER LIKE CONDITIONS.

This shows that there is little or no difference in the use of exhaust or live steam under like conditions, but there is an advantage in using superheated steam in total efficiency, whether exhaust or live steam, due to the less

amount of condensation lost from the mains. If the condensation were returned to the boiler, instead of being wasted to the sewer, the feed temperature would become, in this case, 198° F., instead of 210° F.

There is, however, an apparent difference of about 13%, due to the heating of the feed water in the power house and this is represented roughly by the initial feed temperature condition. There is, however, no actual difference except that due to the addition of make up water at the feed temperature, obtained from condensed exhaust steam used for feed purposes.

There is also the actual saving in loss of water by the use of superheat which amounts to 373 lbs. per hour, or a saving in water by the use of superheat of 166% over the use of saturated steam.

EFFECT WHERE ALLOWANCE IS MADE FOR RECOVERY OF WATER AND HEAT.

If the water and heat recovered from the use of condensed exhaust steam in heating feed water from 60° to 210° is allowed for, it will be as follows:

The latent heat of 17.2 lbs. absolute is 965.2 B. T. U. The difference in B. T. U. required for 210° feed and 60° feed is $178-28=150$ B. T. U. $150 \div 965.2=0.1554$ lbs. steam condensed per pound per second. For the saturated steam, this will be $0.1554 \times 5.33=0.83$ lbs. water saved from condensed exhaust steam. There is lost in the mains on saturated steam 0.1672 lbs. per second. $0.83-0.1682=0.6618 \times 3{,}600=2{,}382$ lbs. water per hour. The reduction in heat for feed water required would be 0.83×150 B. T. U. $= 124.5$ B. T. U. per second.

With feed at 60° and exhaust for heating it, the initial requirements would be $5{,}997.84 - 124.5 = 5{,}873.3$ B. T. U. For superheated steam the reduction in water recovered would be $0.1554 \times 5.2135 = 0.8102$ lbs. per second. $0.81024-0.0645 = 0.75 \times 3{,}600 = 2{,}700$ lbs. water per hour recovered, as against 2,382 lbs. for saturated steam. The heat reclaimed in the condensation used will be 0.81204×150 B. T. U. $= 121.8$ B. T. U. per second. This would mean a reduction in the heat requirements of superheated steam of 121.8 B. T. U. or $5{,}940.8-121.8 = 5{,}819$ B. T. U. as the initial heat required for superheated steam.

Therefore, the efficiency for the feed temperature of 60° F. would change by use of exhaust steam for heating the feed from 84.27% and 84.87% for saturated and superheated steam to:

For saturated steam, $5{,}054.63 \div 5{,}873.3 = 86.05\%$, as against 84.27%.

For superheated steam, $5{,}041.9 \div 5{,}819 = 86.63\%$, as against 84.87%.

As there is always more or less exhaust steam from auxiliaries in a power plant, whether the plant is under load or not, the actual apparent difference would be an efficiency as shown by the feed at 210° and saturated steam of 97.23% to the other extreme of superheated steam and a feed of 60°, or 84.87%, depending on the available supply of exhaust steam for feed purposes, or an apparent difference of 12.5%

The actual difference in efficiency, if the feed were 60° initial in both cases and the use of exhaust steam for feed water accounted for, is 84.87% for live steam and superheat, and 86.06% for saturated steam, or a difference of 1.19% in favor of the exhaust steam saturated for heating. This may vary all the way from 84.87% to 97.23%, dependent on the feed water arrangements and exhaust available for feed purposes.

As a matter of fact, there is actually no difference in the use of exhaust or live steam for heating purposes, provided they are under the same conditions as to quality, pressure and temperature. In most plants, conditions may obtain where the exhaust steam and live steam may be under like conditions or vice versa.

For the reasons given above, and on account of the confusion arising from the use of inexact engineering terms and statements, the heating by exhaust or live steam should cease as a differentiation, and the quality, temperature and pressure should be considered. Then it may be either exhaust or live steam that has the advantage, depending on its condition.

NOTE—*Through a typographical error, the true formula for draft intensity, published in the December issue, was incorrectly given. It should be as follows:* $D = [(7.6 \div T_a) - (7.9 \div T_o)]\, h$ *in which* T_a *and* T_o *are the absolute temperature or the thermometric temperature* + 460° F. d *is the draft in inches of water and* h *the effective height of the chimney.*

Life of Wood Pipe for Conveying Water.

That the life of wood pipe should be at least 20 years, if the pipes are fully exposed and supported free from all contact with the soil, if the material is either fir or redwood, and if the pipe has been properly maintained, is the conclusion of a specialist of the United States Department of Agriculture in a professional paper on "Wood Pipe for Conveying Water for Irrigation" (Bulletin No. 155). The new bulletin which consists of 37 pages, contains a number of figures and tables of practical use to engineers. Continuous stave pipe and machine-banded pipe are described in great detail and many specific instances are given to show how long wood pipe may be expected to last under special conditions.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Programme for Annual Meeting.

Plans completed for the professional and other sessions of the annual meeting of The American Society of Heating and Ventilating Engineers provide for a meeting that will rank well up with those of previous years, if not exceeding them in variety and interest.

As stated in last month's issue, the meeting will extend from January 20 to January 22, or from Wednesday to Friday, inclusive. To carry out the provisions of the constitution a session will be called for Tuesday, January 21, which will immediately be adjourned to the following day.

Papers received for presentation at the annual meeting include the following:

The Centrifugal Fan, by the late Frank L. Busey.

The Recirculation of Air in a Schoolroom in Minneapolis, by Frederic Bass.

A Study of Heating and Ventilating Conditions in a Large Office Building, by C. E. A. Winslow.

Some Data on Warm Air Heating, by Roy E. Lynd.

Cinder Removal from Flue Gases of Power Plants, by C. W. Grady.

The Problem of City Dust, by Reginald Pelham Bolton.

The Burning of Crude Oil as Fuel on the Pacific Coast, by H. S. Halsey.

Flow of Steam in Pipes by J. S. Otis.

The Heating Value of Exhaust Steam by D. M. Myers.

Engine Condensation, when the Exhaust is Used for Heating, by Perry West.

Studies in Air Cleanliness, by M. C. and G. C. Whipple.

Gas Appliances for Heating, by George S. Barrows.

The entertainment program provides for the usual outings for the ladies. Trips of inspection for the men between sessions have also been arranged, one of which will be made to the plant of the Vitagraph Company, manufacturer of moving picture films.

The annual dinner of the society will be held at the McAlpin Hotel, Thursday evening, January 21st, while on Friday evening the members and guests will form a theatre party.

New Members.

Following are the names of those recently elected to membership in The American Society of Heating and Ventilating Engineers:

MEMBERS

Charles A. Blaney, Kalamazoo, Mich.

Thomas P. Brennan, 502 West 141st Street, New York.

Charles H. Eastman, 235 Congress Street, Boston, Mass.

Laurence Franklin, 62 High Street, Boston, Mass.

Edgar W. Mandeville, 126 Hawthorne Street, Brooklyn, N. Y.

Albert C. Townsend, 22 West 84th Street, New York City.

John H. Van Zandt, Fort Worth, Texas.

Jas. B. Wigman, Bloomington, Ill.

Fred W. Williamson, 413 Putnam Avenue, Brooklyn, N. Y.

ASSOCIATE MEMBERS.

Theodore W. Jennings 304 Pleasant Street, Winthrop, Mass.

William G. LeCompte, 80 White Street, New York.

Raymond H. Lindman, 57 Board of Trade, Chicago, Ill.

C. W. Sisson, 136 Federal Street, Boston, Mass.

Charles S. Wood, P. O. Box 455, Newark, N. J.

John A. Wachter, 2422 East Baltimore Street, Baltimore, Md.

JUNIOR.

Frank X. Loeffler, 121 West 113th Place, Chicago, Ill.

Lecture Before New York Chapter on "Heating the Skyscraper and Its Problems."

Details of the piping problems in a modern skyscraper were presented by William H. Driscoll, chief engineer for the Thompson-Starrett Co., New York, at the December meeting of the New York Chapter. Mr. Driscoll's address was illustrated by lantern slides, the views including exterior and interior views of such notable buildings as the Union Central Trust Building in Cincinnati and the Municipal Building, the Woolworth Building and the mammoth new Equitable Life Building in New York.

Mr. Driscoll said that one of the greatest problems in the heating of a skyscraper is the heat losses, especially the leakage of air, not only in the upper stories, but also on the lower floors, due to the updraft. It is also true of skyscrapers that they are usually designed on comparatively short notice, necessitating quick and accurate work in the making of the drawings.

The usual method of supplying heat in tall buildings, he said, is to have an up-feed supply to take care of the first floor only. The balance of the system is divided into sections at different levels. In the Wool-

worth Building there are three such sections.

Mr. Driscoll devoted most of his talk to the equipment in the new Equitable Building. He said some idea of the size of this structure could be gained from the fact that while the Union Central Building in Cincinnati was recently the largest office building in the world outside of New York, the Equitable Building has no less than five times as much floor space as the Cincinnati building.

It contains a total of 155,000 sq. ft. of direct radiation, divided into 5,000 radiators. The exhaust riser, which he described in detail on account of the care required in its design, is 34 in. in diameter and weighs 85,000 lbs. Provision was made for an expansion of 8 in., and this was found to be very close to that which occurred when the steam was turned on. It was necessary to use great care in the location of the flanges so that they would not come in contact with the girders.

There are 132 return raisers on the job, containing 80,000 ft. of pipe. Other statistics include 6,000 fittings and 48,000 ft. of piping used in the radiator connections.

Mr. Driscoll called attention to the need of economizing every cubic inch of space possible in the installation of the equipment on account of the rental value of the space and he referred to the difference between the practice in New York and in Chicago. In New York the radiator branches and the risers are concealed, while in Chicago they are usually run exposed. He expressed his belief that it was probably better practice to run them exposed, but that the space values in the New York buildings were so large as to make the owner willing to take a chance as to the tearing up of the floors or walls for necessary repairs.

This matter of economy of space applies also to the depth of the floor fills, and every effort is made to run the horizontal pipes as close as possible to the beams. Where allowances have to be made for riser expansion, it is necessary to figure this down to a fine point.

In the Woolworth Building, which is equipped with a three-pipe system, he said the third pipe was installed partly to take care of the practically level branch connections to the radiators. While this added greatly to the cost of piping, it also reduced to a large extent the cost of the floor fill.

The speaker called attention to the use of single-column radiators located in many cases a little farther away from the window than usual. He said the advantage of this arrangement was that if it were found desirable to install larger units, there would be room for double-column radiators of the same length, whereas if it had been necessary to install longer one-column radiators, it would be necessary to tear up the floor to rearrange the piping.

Another point emphasized by the speaker was the importance of having the car tracks in the boiler room exactly 8 ft. from the furnace fronts. This, he said, enabled the fireman to shovel the coal and ashes without taking a step each time, which was a very important point to remember.

A number of views presented showed the intricate mazes of piping, which, the speaker stated, sometimes ran so close that there would be practically no space between the pipes. Moreover, this had to be figured out before the construction began.

In addition to the main business of the evening, the chapter voted to appoint a special committee to co-operate with Superintendent of Buildings Miller, of the New York City Building Department, in the preparation of proper heating and ventilating requirements for the new building code, which is in preparation. The appointments will be made by President Timmis and announced later.

The plans were given of the chapter's entertainment committee for the annual meeting of the Heating Engineers' Society. These plans include a dinner at the Hotel McAlpin on the evening of Thursday, January 21, and a theatre party for all on Friday evening, the 22d. This, it will be noted, is a change from previous years, when the dinner was held on a Wednesday evening.

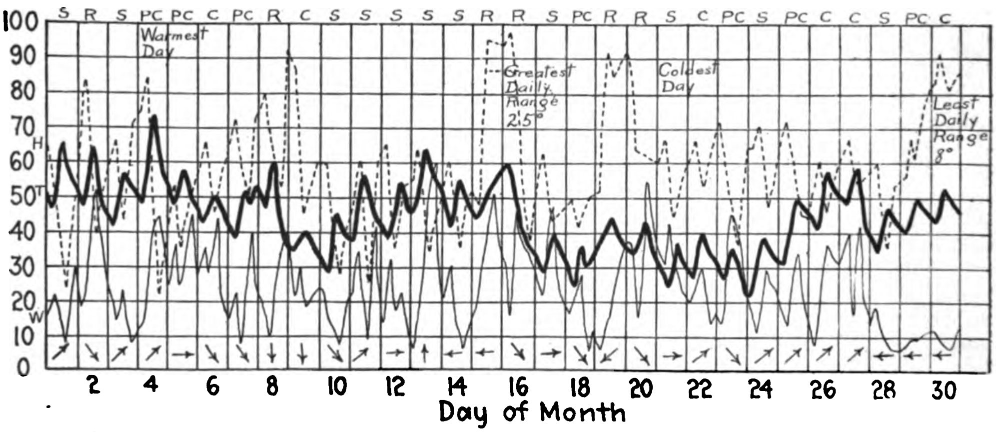
Illinois Chapter.

Dr. E. Vernon Hill, of the Ventilating Inspection Bureau of the Chicago Health Department, was the principal speaker at the December meeting of the Illinois Chapter, his topic being "Air Conditioning for Residences." Following Dr. Hill, A. Bement described a device for humidifying residences, which aroused much interest. Other speakers were Frank Douglas, D. I. Cook and Prof. J. W. Shepard. About 25 members were present.

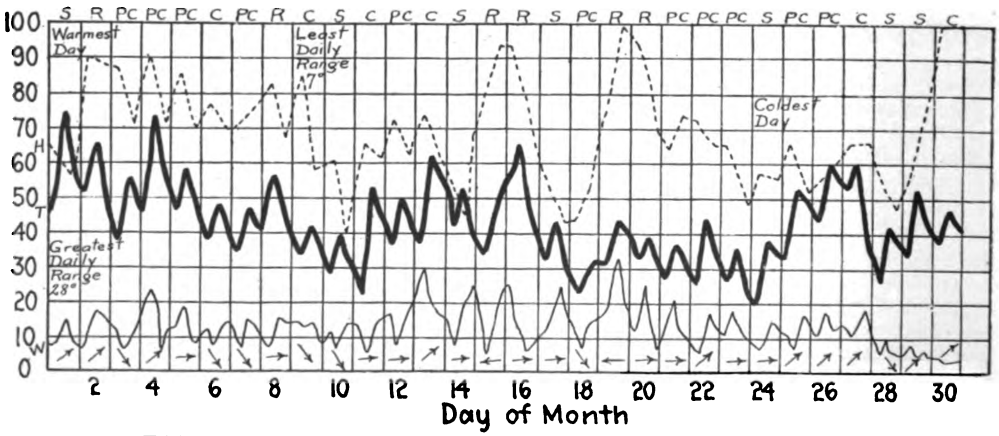
The January meeting will be devoted to a discussion of "Restaurant Ventilation" and "Methods of Correcting Defective Jobs."

The Weather for November, 1914.

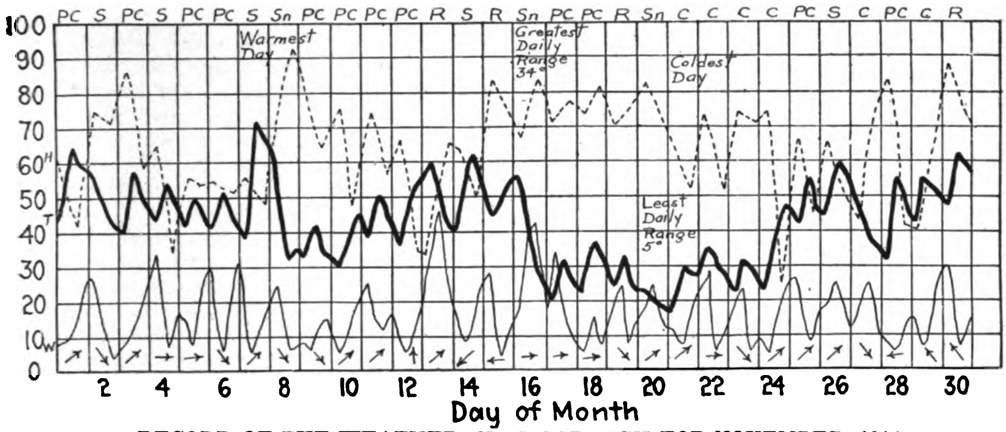
	New York	Boston	Pittsburg	Chicago	St. Louis
Highest temperature, degrees F.	73	74	72	71	80
Date of highest temperature	4	1	7	1	6
Lowest temperature, degrees F.	22	20	18	12	13
Date of lowest temperature	23	24	21	20	19
Greatest daily range, degrees F.	25	28	34	28	30
Date of greatest daily range	16	1	16	15	6
Least daily range, degrees F.	8	7	5	5	8
Date of least daily range	30	9	20	16	13
Mean temp. for month, deg. F.	44	43	43	44.4	50.3
Normal mean temperature for month, deg. F.	44	41.2	42.9	39.2	43.4
Total rainfall, inches	2.08	2.72	1.35	0.33	1.53
Total snowfall, inches	—	Trace	4.0	Trace	—
Normal precipitation, this month, in.	3.44	4.1	2.55	2.5	2.88
Total wind movement, miles	15,325	8,494	9,378	10,006	9,499
Average hourly wind velocity, miles	21.3	11.8	13.5	13.9	13.2
Prevailing direction of wind	S. W.	W.	S. W.	W.	S. W.
Number of clear days	11	7	5	17	21
Number of partly cloudy days	9	11	13	3	4
Number of cloudy days	10	12	12	10	5
Number of days on which rain fell	8	6	7	6	5
Number of days on which snow fell	—	—	3	—	—
Snow on ground at end of month, in.	—	—	—	—	—



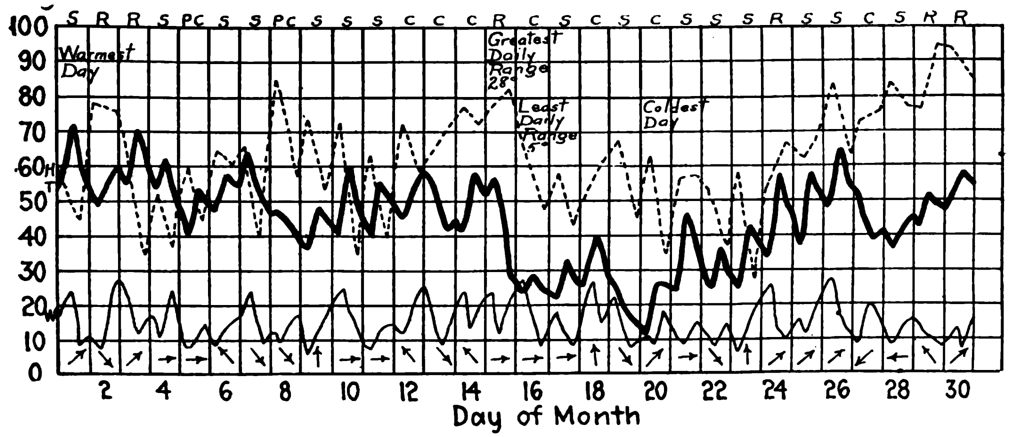
RECORD OF THE WEATHER IN NEW YORK FOR NOVEMBER, 1914.
(Hourly Observations of the Relative Humidity Are Recorded on This Chart).



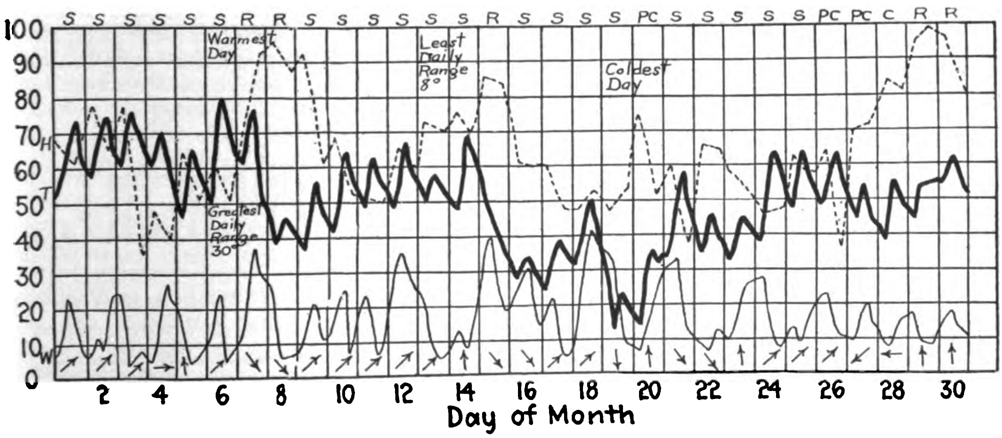
RECORD OF THE WEATHER IN BOSTON FOR NOVEMBER, 1914.



RECORD OF THE WEATHER IN PITTSBURGH FOR NOVEMBER, 1914.



RECORD OF THE WEATHER IN CHICAGO FOR NOVEMBER, 1914.



RECORD OF THE WEATHER IN ST. LOUIS FOR NOVEMBER, 1914.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

Horizontal Air Currents Advocated for Room Ventilation.

Referring to the theory now widely held that heat stagnation is responsible for many and perhaps most of the effects which we have been accustomed to refer to as defective ventilation, Arthur H. Barker, in his recent address before the British Heating Engineers' Society, expressed himself as being equally sure that this was not the whole truth, and that there is something in ventilation over and above the loss of heat and the suppression of smell.

He is quite convinced, he said, that all air of the same temperature, pressure, humidity and velocity has not the same effect on the human organism. Air loses that quality, whatever it is, which with present knowledge we can only describe as crispness when it passes over accumulated dirt, or into close contact with metal, or through a long underground pipe channel, or when it is heated by a hot surface, for this quality of crispness is not merely a matter of temperature, humidity and velocity. Still, we might provisionally accept the theory that the temperature, humidity and velocity of air in a room are points of very great importance in the ventilation, and that one of the chief, but not the only, reason for this importance is that they determine jointly the rate of heat loss from the body.

If we accept the view that the object of controlling the temperature, humidity and velocity of air is solely to regulate the rate of heat loss from the body, it is evident that the only instrument we require to measure the effect of ventilation is one which will enable us to measure the joint effect of these three factors as far as they effect the abstraction of heat from the body. On this assumption the possession of such an instrument at once raises the science of ventilation to a higher plane, for it enables us to measure the success of a scheme of ventilation.

Mr. Barker proceeded to describe two instruments devised by Dr. Leonard Hill with this object, and said their invention was an event of the utmost importance. If the control of heat loss is the sole object of ventilation (a theory he himself does not accept) then a modified form of these instruments is all that is required to show whether a room is well ventilated or not.

Mr. Barker's own view is that we need at least in addition to determine the velocity of movement at all parts of the room; also what he calls the radiant temperature and the absolute temperature of the air itself; the amount of dust in the air, and, perhaps, the amount of organic products in the air when the room is crowded.

Dealing with different ways of introducing air into a room, Mr. Barker said that all physiologists are agreed that the rate of loss of heat from the face and hands ought to be far greater than that from the feet, which would indicate that downward ventilation is superior from this point of view. The view he himself holds strongly is that a horizontal velocity must also be produced before the indoor ventilation can be regarded as satisfactorily accomplished, and that it is necessary either to stimulate the nerves of the skin or some other physiological purpose quite independently of the loss of heat from the body.

We have to find by experiment what is the maximum velocity people can endure, and by subjecting a large number of people of different physique to the same experiment and taking careful note in each case, we might conceivably arrive at a certain medium velocity of air of suitable temperature and humidity which would not be perceptible to anyone as an uncomfortable draft, while in all cases producing a feeling not of cold but of refreshment. This is the velocity of air which the ventilating engineer should aim to produce.

Mr. Barker's own view of the method of securing horizontal velocity is from the back to the front of a room. Visible rotating fans are out of the question, in his opinion, and we would have to introduce the air through gratings in the wall.

To summarize the observations which appeared to him to be necessary in order that we might get a complete idea of the state of ventilation of any given room, he stated that we must have wet and dry bulb thermometer readings; that we must know the absolute temperature of the air and the mean radiant temperature; and should have readings indicating the velocity of the air in all parts of a room when the room is full. We should also have the analysis of the air and particularly knowledge as to what amount of organic products exist in the room. Further we should take the electrical readings and determine the degree of ionization of the air of the room.

CORRESPONDENCE

Lift Fittings and Lift Pockets in Vacuum Steam Heating Work.

EDITOR HEATING AND VENTILATING MAGAZINE:

On pages 25 and 26 of your September, 1914, issue, special lift fittings and lift pockets for vacuum return lines are shown. Will you kindly explain how these devices work and what trouble they avoid? Will you also explain under what conditions of temperature, vacuum, etc., it is necessary or advisable to install them? Is there any choice between the special lift fittings and the lift pocket?

EDWARD L. WILDER.

Rochester, N. Y., December, 1914.

REPLY BY MR. T. W. REYNOLDS.

Lift pockets are necessary in a vacuum return system when it is desired to lift the water of condensation from a lower to a higher level. It is obvious that without the use of such fittings, water would not flow through the return which is at a higher level until the lower return had been flooded up to the highest point of its inside diameter. The water would then be lifted and carried back to the vacuum pump in large quantities, until the long horizontal return main had been completely emptied. This would produce an unsteady load on the vacuum pump. Furthermore the radiating surfaces under such conditions will not heat satisfactorily, for the vacuum will only extend to these points at certain times; as, for instance, with the emptying of the return. Also, the return, while filling, automatically decreases its own cross section through which the vacuum exerts itself.

A lift pocket merely insures the lifting of the returns because of the always present well of water as is required in any mechanical device when used for a similar purpose. The water is lifted from this well as fast as it is received; the top of the well being level with the bottom of the return main, because of the vertical lift pipe extending to that point. Furthermore, the lifting device insures a steady operation of the pump and system. Lift pockets are not an experiment, but have been tried out in practice in many installations; and have been used with success, even on 16-ft. lifts. Generally speaking, the necessity for a high lift is rather a remote contingency; which may usually be avoided in a system properly designed.

To make a lifting device by using pipe fittings is not advisable; for extreme care must be used in inserting the lift pipe; there being no way of insuring the position of this pipe, with respect to the lower horizontal return. The probabilities are that the vertical pipe will be extended too far into the tee by the steamfitter, and that it will, therefore, refuse to operate properly, if at all.

The following sketches are submitted in order to show established methods of lifting returns in connection with a lift fitting as manufactured by Warren Webster & Co., Camden, N. J. The sketches are more in detail than those shown in the issue referred to by the correspondent. Full information as to the operation of these devices in connection with the arrangements shown, both practically and theoretically, may be obtained from the manufacturers, who have constructed a device consisting of a glass tube which demonstrates clearly the practicability of the arrangement as shown in Fig. 1. The use of this latter method is only necessary in extreme cases,

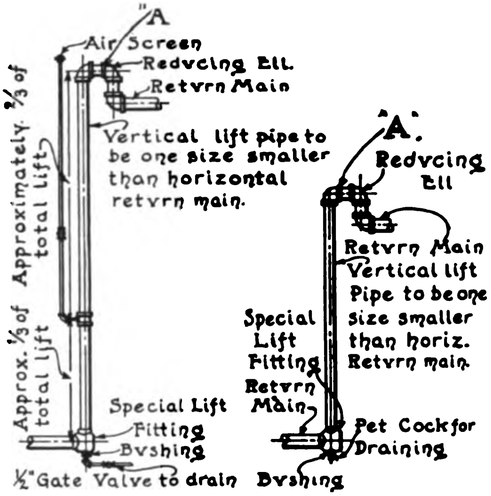


Fig. 1.—Method of Injecting Air Into High Lifts, Where Lift Exceeds 6 Ft.

Fig. 2—For Use Where Lift is 6 Ft. High or Less.

TYPICAL METHOD OF INSTALLING LIFTS, WITH SPECIAL LIFT FITTINGS, IN VACUUM RETURN LINE SYSTEMS.

which, as previously stated, may be usually avoided.

The small ⅛-in. pipe is open to the atmosphere at a point above the upper return main, and admits air to the rising column of water in the vertical pipe. The cock on this small line is but slightly cracked open to admit air only in small quantities. This produces a lightening or aerating effect in the column lifted, similar to that effected by the use of an air lift pump, whereby air at a higher pressure is admitted to the water near its lower level. The inherent expansive force of this air raises the water, and being in bubbles of various sizes it produces a column of water lighter than another of the same height; consequently the water is raised above the level of the surrounding water.

The loops in the piping shown at points "A" are for the purpose of preventing the water from falling back in the vertical pipe as it is lifted. All other necessary directions for the proper installation of these devices are shown in the sketches.

A vacuum in a return main will have a temperature corresponding to the inches of vacuum carried, which ordinarily is about 10 in. Temperature does not affect the operation of these devices, but the higher the vacuum, the greater will be the lift obtainable. Theoretically 1 in. of vacuum will lift 1 ft. of water or static head. In practice this has been exceeded where lift fittings have been used.

If a lifting device is made up of pipe fittings, its run of tee should be two sizes larger than the horizontal return.

Radiation as Figured by Different Rules.

Editor Heating and Ventilating Magazine:

In your November issue, you give two tables by different authors for figuring radiation. The first, on page 43, is by Mr. Gifford and I will refer to this as "A." The second is on page 56, which is an explanation of an article which appeared in your September issue, and I will refer to this as "B."

I have taken a typical room, 12 x 15 x 9 ft., with 12-in. brick wall, two 3 x 7 ft. windows with single glass, 12 x 9 ft. exposed wall with west exposure, having a heated room below and an unheated attic above.

I have figured this room by Table A, Table B and Table C. For Table C I have used the old, well-known method of 2-10-200. Following are the results:

TABLE A.

Cubic contents, 1,620 × 1.6	= 2,592
Exposed wall, 108 × 21	= 2,268
Ceiling, 180 × 21	= 3,780
Glass, 42 × 98	= 4,116
	12,756

12,756 ÷ 165 = 77 sq. ft. of radiation.

TABLE B.

Cubic contents, 1,620 × 0.005	= 8.1
Exposed wall, 108 × 0.085	= 9.18
Ceiling, 180 × 0.22	= 3.96
Glass, 42 × 0.39	= 16.38
Sq. ft. of radiation	37.62

TABLE C.

Cubic contents, 1,620 ÷ 200	= 8.1
Exposed wall	108
Ceiling	180
Total exposure	288
Glass, 42 ÷ 2	= 21.0
Exposure, less glass, 246 ÷ 10	= 24.6
	53.7
Add 10% for west exposure	= 5.3
Sq. ft. of radiation	59.0

You will see from the above tables that there is a wide variation in the amount of radiation required when figured by the three methods, especially by the two methods given in your November issue.

If you can give any information as to which of the tables is the more nearly correct or as to where the authors got their information in making up the tables, it will certainly be appreciated. F. W. Rose.

Minneapolis, December, 1914.

REPLY BY MR. WILDER.

Referring to the table of coefficients given in my recent report, the example as worked out by Mr. Rose is correct.

As to the derivation of the table, the figures in the first column, which represent the B. T. U. loss per square foot per hour per degree difference in temperature, are taken from various authorities on heating and ventilating constants. If you compare these figures with other published constants, you will find that they are a little more liberal than the values usually given.

The figures in Column 2 are derived from those in Column 1 by multiplying by 80—temperature difference—and dividing by 240—B. T. U. allowance per square foot of radiation.

The figures in Column 3 are derived from those in Column 1 in a similar manner, except that 280 is used as the divisor. The figures in Column 2 are for a vapor system of heating and the figures in Column 3 are for a low pressure steam system. The figures in Column 4 give the demand in pounds of steam per hour and are figured as follows:

The figures in Column 1 are multiplied by 80 and divided by 960, it being assumel that 1 lb. of steam will deliver 960 B. T. U.

Work of the Heating and Ventilating Division of Cleveland for 1914.

In the report of Virgil D. Allen, inspector of buildings of Cleveland, Ohio, for the year 1914, after referring to the establishment of the office of heating and ventilating engineer for the city of Cleveland, he states that Cleveland is the second city in the United States to give systematic and special attention to this important subject. Due to the financial condition of the city Inspector Allen states that the department has been unable to establish this subdivision on a basis commensurate with the needs of such service.

Under these conditions the work of T. R. Quay, the city's heating and ventilating engineers was limited accordingly, but Mr. Quay's report shows a number of important actions taken.

The most important work of the year, says Mr. Quay, was the rewriting of the building code with reference to heating and ventilation. This part of the code as finally passed and approved was published in abstract in The Heating ane Ventilating Magazine for June, 1914. Mr. Quay states that 500 copies of the ordinance, which is No. 29,798, were distributed.

"This new code," continues Mr. Quay, "has been the subject of considerable favorable comment by some of the trade papers, prominent among which are the *Metal Worker* and The Heating and Ventilating Magazine,

also some unfavorable comments have been made by contractors, principally on account of the fact that a slight additional expense results from building according to the code." Mr. Quay adds that when one or two minor changes have been made, he believes there will be little difficulty in securing its enforcement.

The examination of heating and ventilating plans, continues the report, has been second in importance. This feature of the work was begun March 1. Inasmuch as the old city code, as well as the State building code carried provisions as to heating and ventilating, which were not being incorporated in plans, it was found advisable to suggest to architects and owners the most advisable method of ventilating their buildings, as it was found that few were inclined to have their work designed by experts. Mr. Quay says there have been notably few plans of ventilating systems submitted on which some changes were not required.

Tentative forms have been designed by the division for systematically recording the work of plan examination and as soon as they have proved satisfactory, such a record will be kept.

MORE INSPECTORS NEEDED.

The report states that until money is available to add two heating and ventilating inspectors, the work of inspecting the ventilation of existing buildings must be deferred. This work, says Mr. Quay, is very important and should be taken up at as early a date as possible. He states that he is endeavoring to make at least final inspections on new theatres, picture show buildings, etc., in addition to examining all plans of buildings where ventilation is required.

At Director Stage's request Mr. Quay made a report on the heating and ventilating plans of five new buildings of the City Hospital, on May 22, recommending, among other things, that the heating system be changed from steam to forced hot water. These recommendations were all adopted and considerable time has been required, not only in redesigning this work, but in supervising the erection of same, as well as advising with the director in other branches of the work, such as plumbing, laundry equipment, etc.

Along the same line, Mr. Quay states that he redesigned the heating system of the new machine shop for fire apparatus on Croton Avenue, and, at the request of the Department of Public Service, made the recommendation and wrote the specifications for the necessary changes in the heating system in the City Hall Library building, etc., to accommodate same to the use of steam furnished by the Cleveland Illuminating Company. He has also acted in an advisory capacity at the City Hospital, recommending certain changes in the mechanical equipment of the present buildings, prominent among which have been the heating of the Tuberculosis Sanitarium from the power house and the changes in gas burners, increasing the efficiency of the boilers.

The report shows that during the year 77 heating and ventilating inspections were made.

The Needs of the Heating Profession.

What amounts to a fairly complete summary of the needs of the heating profession is contained in a recent report of a committee of the New York Chapter of the heating engineers' society which is at work on what will be practically a code of ethics for the engineer.

Among other things the committee discusses the question of a legal license for engineers to practice and what the requirements should be for such a license. Regarding the direct employment of engineers, it is pointed out that engineers should have the same authority in deciding engineering questions as is accorded other professional men in the decision of matters pertaining to their work. As a general proposition, it is urged that all engineering work should be placed in the hands of its own specialists. As a step towards accomplishing this end, it is proposed to find out what percentage of engineering work is being handled indirectly by engineers and what consideration is being given engineers.

The matter of fees is to be taken up to determine whether the prevailing fees are productive of work which is satisfactory to the client and creditable to the profession.

It is proposed to look into the question as to whether the science of heating and ventilating, as generally practiced, is productive of as good design as it should be and how much the demand for low cost is preventing the most economical use and thus proving a detriment to the profession.

It is felt that under existing conditions, the engineer is unfairly burdened with the responsibility for the co-operation of his work with that of others, and that much of his time and energy are being spent which is not appreciated or paid for. In addition to investigating this subject, the committee expects to deal with the question as to whether the engineer should be required to give a bond covering the proper operation of work under his charge.

The separation of contracts is another matter proposed for investigation and if the engineering contracts should be separated, whether there should be further sub-divisions of contracts.

In all of the steps proposed the question will come up of the enlistment of the co-operation of the associated professions and trade organizations. The question how this can best be done is one of the matters that will have to be decided before the matters are brought to a final issue.

The committee, which is known as the Committee on the Profession's Efficiency and Welfare is composed of Perry West (chairman), Frank K. Chew and J. I. Lyle.

Massachusetts Chapter.

A discussion on "Public School Ventilation," which formed the topic for the December meeting of the Massachusetts Chapter brought out a full attendance of members, and in addition forty guests were present from the engineering departments of the city and State. The meeting was held at the Revere House, Boston, and followed a chapter dinner.

Eugene C. Baldwin, of the State Board of Education, was the principal speaker. He declared that the ventilation of the Boston public schools is not satisfactory and said that no system has been invented that is not being used in some one of the Boston schools. The school board, he said, is dissatisfied with them all.

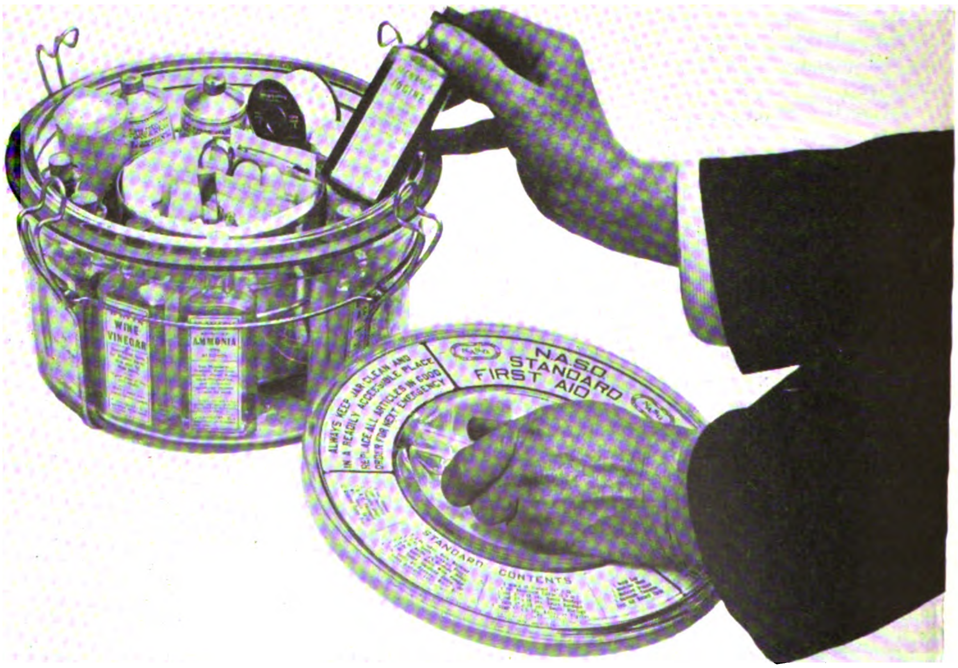
Mr. Baldwin declared that Massachusetts is behind in its present rural school system and expressed the hope that the Board of Education would be instrumental in bringing together the chapter, the board of health and the district police in a movement to effect improvement in ventilating methods.

Other speakers were ex-Mayor Eugene Stone of Quincy, vice-president of the Massachusetts Chapter, who presided; Major J. W. H. Myrick, Commissioner of Public Works Louis K. Rourke; John H. Plunkett, deputy chief of the Massachusetts District Police.

S. H. Wheeler, of Fairfield, Conn., showed lantern slides of schoolhouses he has planned and built in that State.

The N. A. S. O. Standard First-Aid Jar.

A first aid jar, made of glass, has recently been designed which though only about 9½ in. in diameter and 6 in. high, contains every material which a large conference of physicians has agreed upon as necessary for effective first aid treatment. It is known as the N. A. S. O. standard first aid jar, owing to the fact that it has been standardized by the conference board on safety and sanitation and accordingly stamped with the National Affiliated Safety Organizations mark. These jars may be secured from the secretary of any of the associations comprising the conference board, namely: The National Founders' Association, 20 South La Salle Street, Chicago; The National Association of Manufacturers, 30 Church Street, New York; The National Metal Trades Association, Peoples Gas Building, Chicago; and the National Electric Light Association, 29 West 39th Street, New York. They are sold at prac-



N. A. S. O. STANDARD FIRST-AID JAR.

tically cost price, as there is no intention to make a profit on any of the articles standardized by these associations.

American Society of Mechanical Engineers.

The first woman to be elected a member of The American Society of Mechanical Engineers attended the thirty-fifth annual meeting of the society, which was held in New York, December 1-3, 1914. She is Miss Kate Gleason, secretary of the Gleason Works, Rochester, N. Y. Miss Gleason is a graduate of Cornell University where she took the mechanical engineering course and is manager of the large plant of which she is secretary.

The new officers of the society, elected at the annual meeting, are: President, John A. Brashear, Pittsburgh, Pa.; vice-presidents, Henry Hess, Philadelphia; George W. Dickey, New York; and James A. Sague, Poughkeepsie, N. Y.; managers, Charles T. Main, Boston; Spencer Miller, New York; Max Toltz, St. Paul, Minn.; and Morris L. Cooke, Philadelphia; treasurer, William H. Wiley, New York.

Plans of the International Engineering Congress.

Some confusion seems to have arisen in the minds of at least certain of the engineers of this country, between the International Electrical Congress, which it was proposed to hold in San Francisco in September, 1915, and the International Engineering Congress, which is to be held during the same month.

Owing to the unfortunate situation existing abroad, and the impossibility of convening the International Electrotechnical Commission, under whose authorization the electrical congress was to have been held, it has been decided by the governing body of the American Institute of Electrical Engineers to indefinitely postpone the holding of the electrical congress. This does not affect the International Engineering Congress, which goes ahead as originally planned.

Ownership of the New York Steam Company.

In connectiong with the hearings before the New York Public Service Commission of the First District, which resulted in the commission's order to the New York Steam Company that it must replace its mains with a modern form of underground pipe construction, it was brought out that about two-thirds of the stock of the steam company is held by the Andrews Institute for Girls, a charitable institution near Cleveland, O. The president of the company, G. C. St. John, owns another large block and the remainder is held by about 130 small stockholders. It is said never to have paid any dividends, and the last sale of stock reported was at the rate of $1.50 a share. It has long been a matter of speculation on the part of the general public as to who were the owners of this company. The company maintains in all about 12.7 miles of steam mains divided into two systems and served from two stations.

The New York Steam Company was formed in 1881 with an authorized capital of $7,500,000 to take over the franchise of an earlier company, which, however, had done no operating.

Bibliography on Air Conditioning.

A notable bibliography on air conditioning, with references to books and magazine articles, appeared in the Monthly Bulletin of the Carnegie Library of Pittsburgh, for November, 1914, and has since been published in pamphlet form. Although the bibliography is confined to material in the Carnegie Library of Pittsburgh, it is remarkably complete for the field it covers which is that relating to the conditioning of air supplies for buildings. It does not attempt to cover mine, subway or railway car ventilation, or the cooling of air for cold storage or for other industrial purposes.

It is a matter of interest to note that the references to articles appearing in THE HEATING AND VENTILATING MAGAZINE total 86, or more than those credited to any other journal.

The pamphlet is listed in the library's reference list as obtainable for 10 cents, postpaid. It contains 58 pages.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

AIR CONDITIONING—

Wet Air-Filters. Describes recent types for air purification. Ills. 1,200 w. Engng—Oct. 23, 1914. 40c.

FANS—

Fans for Ventilating Work. C. L. Hubbard. Describes forms used for ventilationg, type of motor best suited, and gives rules for determining the capacity and driving power required, etc. 2,200 w. Eng Mag—Dec., 1914. 40c.

GAS HEATING—

Possibilities of Auxiliary House Heating by Gas. W. H. Schofield. Discusses the application to house heating. 1,500 w. Am Gas Ltg Jour—Nov. 16, 1914. 20c.

Water Heating by Gas. H. R. Basford. A paper of value to the salesman in showing the efficiency and comfort of such a device. Ills. 5,000 w. Am Gas Lgt Jour—Nov. 16, 1914. 20c.

VENTILATION—

Possibilities in Ventilation. Extracts from a lecture by Arthur H. Barker. Considers conditions which must give satisfactory ventilation. 4,000 w. Archt, Lond—Nov. 6, 1914. 40c.

NEW DEVICES

A New Method of Measuring High Temperatures.

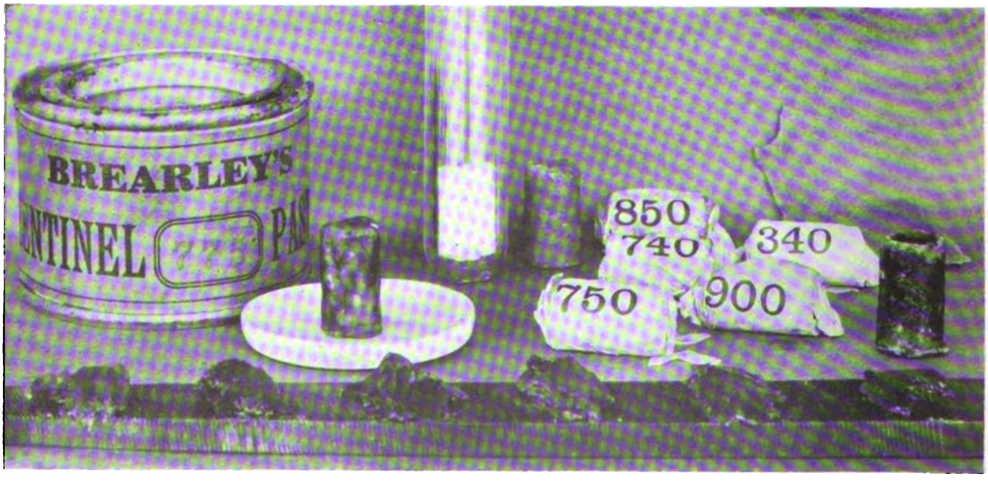
A new method of measuring temperatures wherever heat is applied has just been developed by the Carl Nehls Alloy Co., Detroit, Mich. It provides for the use of different kinds of metallic salts, which are made into molecular mixtures that will melt down at different temperatures throughout the range between 220° and 1,330° Centigrade. Practical means have been devised for using them in place of the more costly pyrometers. They are also very useful for checking pyrometers. Then a cylinder is placed at the end of the thermo-couple and when it melts the pyrometer should read the same as the temperature marked.

One way is to cast them into solid cylinders 7/16 in. in diameter and ¾ in. long, as shown by those standing on end in the accompanying illustration. Each one is wrapped in a paper on which is printed its correct melting temperature in degrees, Centigrade, as shown by the samples. For all temperatures below 932° F. the Sentinel Pyrometers, as they are known, can be used in an air-tight glass tube, such as is shown in the centre. The salts can then be used over and over again. By using the small porcelain saucers shown, the salts do not run to waste and litter up the place where they are used. This also enables them to be used several times, as the salt melts each time the temperature rises above the one marked on the cylinder and becomes solid again the moment the temperature falls below this degree.

These salts are also made up in the form of a paste. Enough to make several hundred determinations is packed in the tins shown. Pastes with various melting temperatures can be daubed along a steel bar. as shown in the front of the picture, and inserted into furnaces, ovens, retorts, flues, gas mains, steam pipes, etc., to find the temperature at which they are operating. The salts that melt down and those that remain solid will indicate the temperature, which would be between the two. By using a long bar one can determine whether the temperature is uniform in the front and back, top and bottom, or corners of a furnace, oven, kiln, etc.

New Type of Feed Water Regulator.

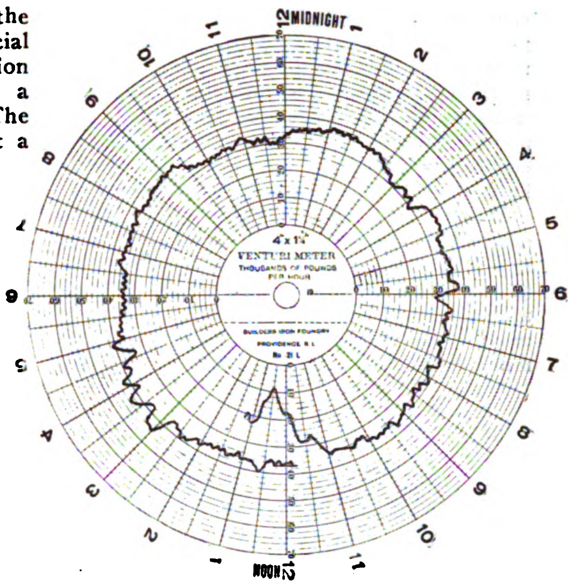
A thermostatically-controlled feed water regulator, designed not only to secure a continuous feed, but positive automatic control of such feed to vary with the boiler load, has been placed on the market by the McDonough Automatic Regulator Co., Detroit, Mich. It is sold under the trade name of the World's Best. It is emphasized that for sudden increases in load and resulting rapid drop in the water level, the regulator valve does not open suddenly, but there is a time element in



SENTINEL PYROMETERS AND PASTE FOR MEASURING HIGH TEMPERATURES.

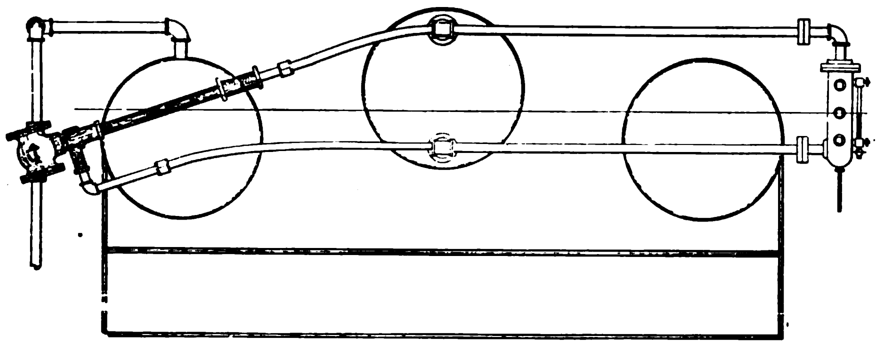
the expansion of the tubes operating the valve. The regulator consists of a special feed valve, two headers and two expansion tubes connected in parallel through a rigid linkage to the feed valve stem. The turnbuckle and pointer indicator permit a very accurate adjustment of the valve.

McDONOUGH FEED WATER REGULATOR COMPLETE.



VENTURI METER CHART SHOWING REGULATION OF FEED ON TWO BOILERS EQUIPPED WITH McDONOUGH REGULATORS.

The regulator is installed in an inclined position, wholly supported by the feed piping, with the connections made to the water column, as shown. In operation the lower end of the tubes are filled with water and the upper with steam. As the water falls or rises in the boiler, it correspondingly falls or rises in the regulator tubes, presenting a greater or less area of the tube surface to the hot steam, causing them to expand and contract accordingly. The inclined position of the regulator gives the greatest variation in exposed tube surface for a given variation in water level and the greatest sensitiveness to variations in load.



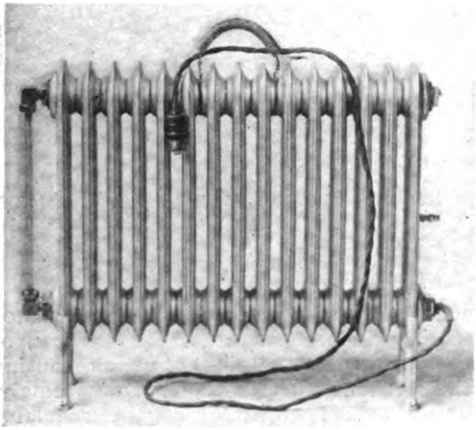
METHOD OF INSTALLING McDONOUGH FEED WATER REGULATOR

No Care Electrical Steam Radiator.

A type of electrical steam radiator, which is described as portable, dustless, noiseless and odorless, has been placed on the market by the Electrical Steam Radiator Co., 644 Congress street, Portland, Me. It is pointed out that it is of special

value as an auxiliary heater. The company reports interesting results of a test made on its household type of radiator, 15 sections, 1,000 watts, 110 volts, having a radiating surface of 18 sq. ft. The height of the radiator was 20 in. The amount of cold water used was 1½ quarts, and it was brought to a boiling point in 17 minutes.

When placed in a room of 2,500 cu. ft, capacity, where at the beginning of the test the temperature was 55° F., this temperature was raised in 1 hour and 20 minutes to 64°. The watts taken by the radiator at the normal voltage, as marked in name plate, was practically 1,000 watts, varying a few per cent above and below as the voltage of the supply rose and fell.



NOCARE ELECTRIC HOT WATER RADIATOR.

Another test made by the meter department of the Cumberland County Power and Light Co. on a 15-section radiator, 20 in. high, containing 1½ quarts of water and having 18.7 sq. ft. of radiation. On 122 volts the radiator drew 1,070 watts, and on 116 volts it drew 1,040 watts. The radiator was heated for three hours. It started to boil the water in 15 minutes and at the end of the test the steam gauge showed a pressure of 6 lbs.

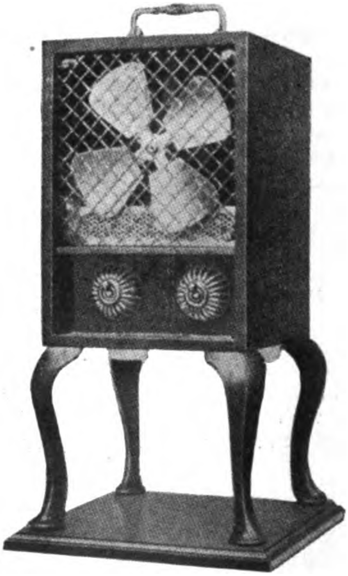
The Nocare electrical steam radiator is made in six sizes, running from 14 to 32 in. high and containing from 10 to 15 sections. It is noted that 300 to 500 watt radiators may safely be attached to the ordinary light sockets.

Harral Pipe Cleanser.

An interesting product for cleansing clogged waste pipes and also for removing accumulations of grease and dirt from machinery, is manufactured by chemical department of the Harral Soap Co., 467 Greenwich Street, New York, and is being sold in the New York district by S. D. Robertson, formerly with the Nason Mfg. Co., New York. The Harral pipe cleanser is a chemical which, when mixed with water, forms a solution hotter than boiling water and eats away all kind of waste matter without injuring the piping or machinery. It is also effective in thawing out frozen pipes. It is stated that a weak solution will not freeze in 10° F. below zero, while stronger solutions will resist lower temperatures in proportion. Mr. Robertson reports a wide sale of this product and uniformly successful results obtained by its use.

Trade Literature.

DEODORIZATION BY THE OZONAIR SYSTEM is the title of an interesting treatise and catalogue featuring the apparatus manufactured by Ozonair, Ltd., 96 Victoria Street, Westminster, London, S. W. The circular takes up the discovery and application of ozone, dividing the applications into (a) domestic and general, covering private houses, mansions, hotels, restaurants, railway trains, ships etc. and (b) commercial and industrial treating of the trouble caused by the handling or storage of such articles as hides skins, etc., or incident to the carrying on of what are known as offensive trades. In the present catalogue the applications are confined to those using portable apparatus and it is stated that with this type, the average cost of producing strongly ozon-



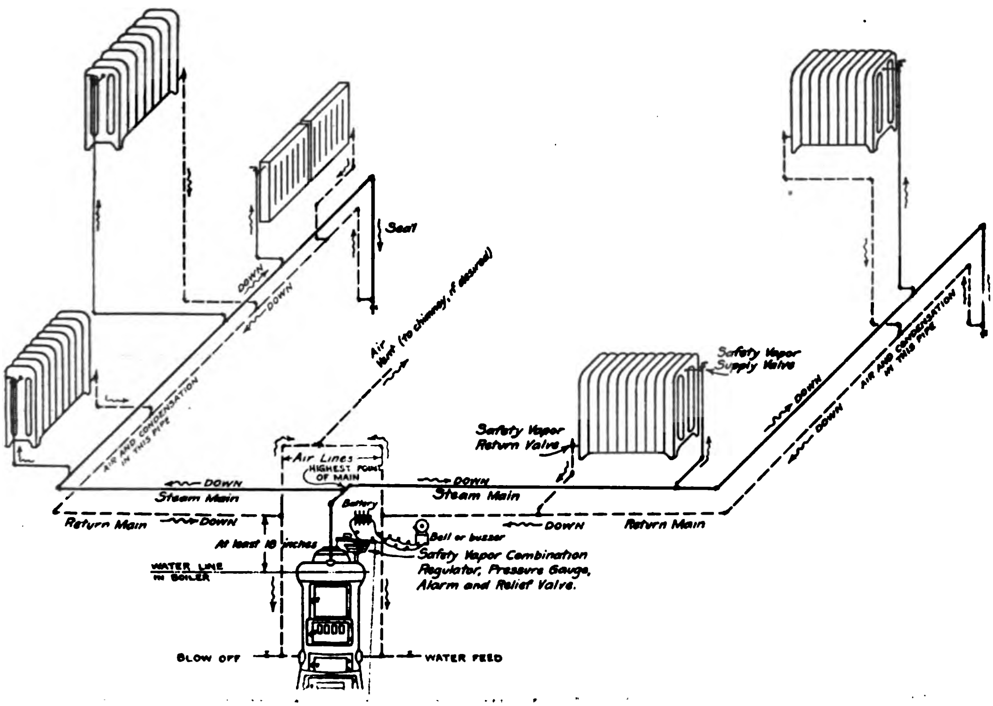
TYPE OF PORTABLE OZONAIR MACHINE DESIGNED FOR DINING ROOMS, SICK ROOMS, ETC.

ized air does not exceed one six-hundredth part of a penny per 1,000 cu. ft. Full directions are included for the guidance of the user in selecting the size and type of apparatus and the illustrations show the differences in each type. Size 8¼x10¾ in. Pp. 16.

IMPROVED TYPE OF ADSCO GRADUATED RADIATOR VALVE.

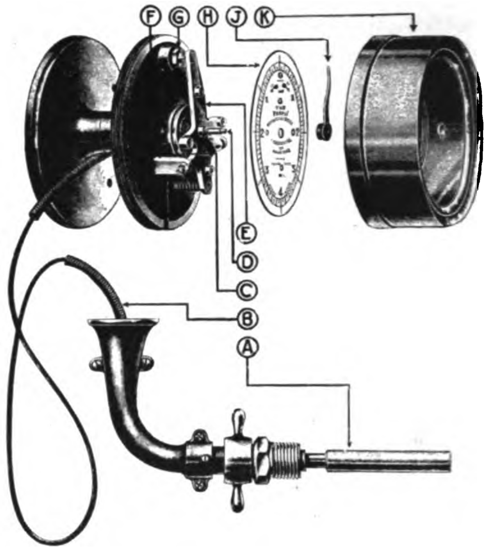
Adsco Graduated Radiator Valves, improved type, used in connection with the atmospheric system of steam heating, are featured in a new circular issued by the manufacturers, the American District Steam Co., North Tonawanda, N. Y. This valve travels from closed to full open with a three-quarter turn and a pointer indicates any fractional position between the two extremes. It is recommending as affording absolute control of individual radiators, permitting the flow of just the amount of steam needed in each radiator to maintain the desired temperature. The valve, it is stated, will not become clogged, or stick after remaining idle. Their various capacities are arranged in multiples of 5 sq. ft. of direct radiation, which have been established as the result of extensive tests to determine the ratio of the amount of steam under given pressure through the radiator valve, to the amount of steam condensed per square foot of radiation under maximum demand conditions. The valve is listed at $5.00.

Safety Vapor Heating System, one of the most recent additions to this method of steam heating, is fully described in a catalogue received from the manufacturers, the Safety Vapor Heating Co., 73 West Eagle Street, Buffalo, N. Y. The manufacturers state that while this system follows the general principles of other vapor heating systems, the devices or means by which this principle is applied are noteworthy. The Safety vapor regulator, for instance, is made entirely of metal, with no rubber diaphragm or rubber connections, and may be expected to respond to a change of pressure of less than ¼ oz.



TYPICAL LAYOUT OF A SAFETY VAPOR HEATING SYSTEM.

As shown in the view given herewith of a typical installation, this regulator is connected directly to the steam dome of a boiler by a short nipple. The front end of the lever is connected by a chain or cable to the draft damper in the ash pit; the rear end to the check in the smoke hood. On the front of the regulator is a mercury gauge glass showing the pressure in the boiler in ounces. The wires marked show the two electrical connections to the alarm. When the mercury in the gauge glass rises to a predetermined point, contact is made and a buzzer or bell will warn those in the house that the system is being mistreated. If, however, this is not heeded, pressure will be relieved through the opening in the top. The Safety vapor supply valve is made in one size, ¾ in., one simple adjustment on the outside of the valve being all that is necessary to adapt it to any size of radiator. Other devices included in this system are the Safety vapor automatic alarm, already mentioned; and the Safety vapor relief, to allow the excess steam to escape when the pressure rises above 8 oz. Size 3½x6¼ in. Pp. 24.



A—Thermostatic bulb.
B—Thermostatic tube.
C—Vapor Capsule.
D—Adjusting Post.
E—Transmitting Lever.
F—Spring.
G—Air Pressure Regulator.
H—Dial.
I—Pointer.
K—Cover.

MECHANISM OF PERFECT TEMPERATURE CONTROLLER.

Perfect Automatic Controller for Temperature and for Pressure is the subject of a new bulletin (No. 297) published by the C. J. Tagliabue Mfg. Co., 18-88 Third St., Brooklyn, N. Y., in which this interesting system is described in detail. It is intended for use wherever the temperature to be maintained lies between 100° F. and 400° F., and, with slight modifications, it may be used for any value of pressure within the limits of commercial practice. This apparatus, like all other Tagliabue automatic temperature controllers, operates by automatically adjusting a valve or damper that regulates a tempering medium, such as steam hot or cold water, hot or cold air, etc. A typical application of the controller to a tank that is heated by steam is shown in the accompanying illustration. The Tagliabue simplex pressure controller is used to keep the steam at a constant pressure independent of the boiler fluctuations. Before starting the plant for the first time, the adjusting post is set for the temperature that it is desired to maintain. When the tank is cold and, therefore, the temperature is not

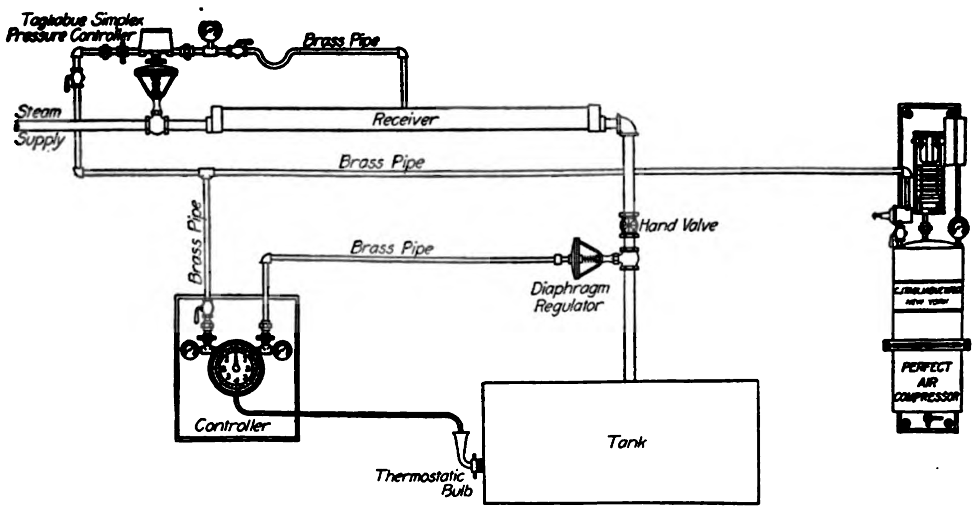


DIAGRAM SHOWING OPERATION OF PERFECT TEMPERATURE CONTROLLER.

sufficient to vaporize the liquid in the thermostatic bulb, no pressure exists in the thermostatic system; that is the vapor capsule is contracted beyond contact with the adjusting post. In this position the spring holds the ball tightly against the air inlet port and thus no air pressure is admitted to the top of the diaphragm, which is held wide open by the combined action of the coil spring on its stem and the pressure of the entering steam.

As the tank temperature rises and approaches the desired degree the liquid in the thermostatic bulb vaporizes and establishes a pressure in the system that corresponds to the temperature of the medium in which the bulb is immersed. The action of this pressure is to expand the top of the vapor capsule and bring it into contact with the adjusting post, thus forcing the lever away from the valve pin and allowing the ball to rise and admit air pressure to the diaphragm motor, thereby partly closing the steam inlet valve. The pressure in the controlled line that leads to the diaphragm motor is less than the initial air pressure because of the throttling action of the ball and also because of the leakage through the upper port of the valve chamber provided for that purpose.

When the temperature reaches its proper value, the vapor pressure in the thermostatic bulb corresponding to that temperature keeps the ball at an intermediate position which in turn supplies air to the diaphragm motor at an intermediate pressure, thereby keeping the steam valve open just enough to maintain the temperature.

The slightest variation above or below normal temperature will cause an instant and corresponding variation in the vapor pressure and therewith a like variation in the position of the ball so as to continually vary the opening of the steam valve in such a way as to keep the temperature always at the correct degree.

The use of a saturated vapor and of a patented air pressure regulating valve are emphasized by the manufacturers as being the important points of excellence of this system. The use of a saturated vapor, it is stated, results in great sensitiveness, adaptability, durability and flexibility, while the type of air pressure regulating valve used is notable for its simplicity, absence of mechanical friction, reliability and accuracy. Size 8½ x 11 in. (standard). Pp. 16.

Other recent bulletins issued by the C. J. Tagliabue Company are No. 310, on "Instruments for Steam Plant Use," including thermometers, temperature controllers, pressure controllers, pyrometers, thermoscopes and syphon draft gauges; and No. 216 on "How It Works," being devoted to the company's Faultless temperature controller, built on the expansion stem principle. Size of both bulletins, 8 x 11 in. (standard). Pp. 48 and 24, respectively.

FOXBORO THERMOMETERS AND THERMOGRAPHS, containing several new and important improvements, are illustrated and described in a new bulletin (No. 91) published by the Industrial Instrument Company, Foxboro, Mass. Special attention is called to the fact that in the construction of these instruments no mercury is used, the principle involved permitting a much wider range of use, especially with the long-distance types, as the readings are not affected by the temperatures surrounding the instruments. Each part is taken up separately and views given showing clearly the construction of each part. There are also a number of typical records made by the recorders in actual service. Size 8x11 (standard) pp. 52, punched for binding. Another recent publication is devoted to the Foxboro differential recording gauges and orific meters for gas. These instruments are designed to record with precision the differences in pressures obtained by the use of orifice plates, Pitot tubes or Venturi throats with an accuracy heretofore impossible, permitting the measurement of the velocity and volume of liquids or gases flowing through pipes under pressure; also to record the heights of liquids in vessels under pressure, such as the height of water in a steam boiler. Size 8x11 in. (standard). Pp. 20, punched for binding.

MARSH REFLUX AUTOMATIC RETURN LINE THERMOSTATIC TRAP, for use with graduated control, vacuum, modulation, vapor and atmospheric systems of steam heating, are the subject of a circular devoted to this device, published by the manufacturers, Jas. P. Marsh & Co., Chicago, Ill. The valve is operated by means of the expansion and contraction of the diaphragm produced by the vaporization and condensation of volatile liquids. The expanding diaphragm, it is stated, has been used for fifty years in the construction of locomotive gauges. A unique feature of the valve is its fluid reservoir which, together with the composition seat, relieves the force of the expanding member. This reservoir is a tube, containing, with the diaphragm, the volatile liquids. An accompanying illustration shows a typical heating layout equipped with the Marsh reflux traps.

PAGE VOLUNTEER AND MONARCH BOILERS, for steam and hot water heating, are described and illustrated in a complete and handy catalogue covering the products of the Wm. H. Page Boiler Co., New York. The prices are those for 1915. All of the necessary data are included, both for the Volunteer round type and

HARVARD FRESHMAN DORMITORIES.

the Monarch sectional type, while 21 pages are devoted to miscellaneous information for the steam fitter. Size, 4½ x 7½ in. Pp. 80.

Incorporation of Almirall & Co., New York.

Due to the death of the late Quimby N. Evans, it is announced that the co-partnership heretofore existing between Q. N. Evans, J. A. Almirall and W. C. Adams has been dissolved and the corporation of Almirall & Co., Inc., has succeeded to that business. The new corporation has the same personnel as the former co-partnership and is prepared to carry on the business with the same dispatch, thoroughness and integrity as characterized the former company. The company's activities include the design and installation of heating, ventilating and power plants, sprinkler systems and forced hot water heating systems. The new corporation is capitalized at $200,000 and the incorporators are J. A. Almirall, W. C. Adams and W. J. Wood, all of New York. The present quarters of the company at 1 Dominick street, New York, will be maintained.

Large Pipe Covering Contract.

The pipe insulation contract for the new Utah State Capital at Salt Lake City, for which R. K. A. Kletting was the architect and the James C. Stewart Co. the contractors, was recently awarded to the H. W. Johns-Manville Co., New York. The high pressure pipes will be covered with J-M asbesto-sponge felted pipe covering, a product made up of lamenations of felt composed of asbestos and finely-ground sponge. The materials being naturally cellular, they form the basis for the claim as to the large number of "dead air" cells they contain, and therefore their high heat insulating value.

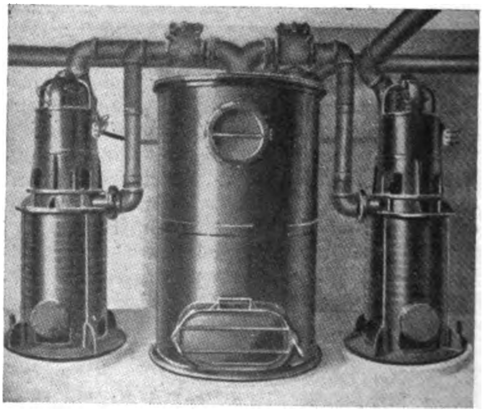
The heating pipes will be covered with J-M asbestocel pipe covering, which is built up on the arch principle. Sealed air channels run around the pipe, instead of parallel with it, thus preventing the circulation of air and consequent heat radiation.

Test of Vacuum Cleaning Plant.

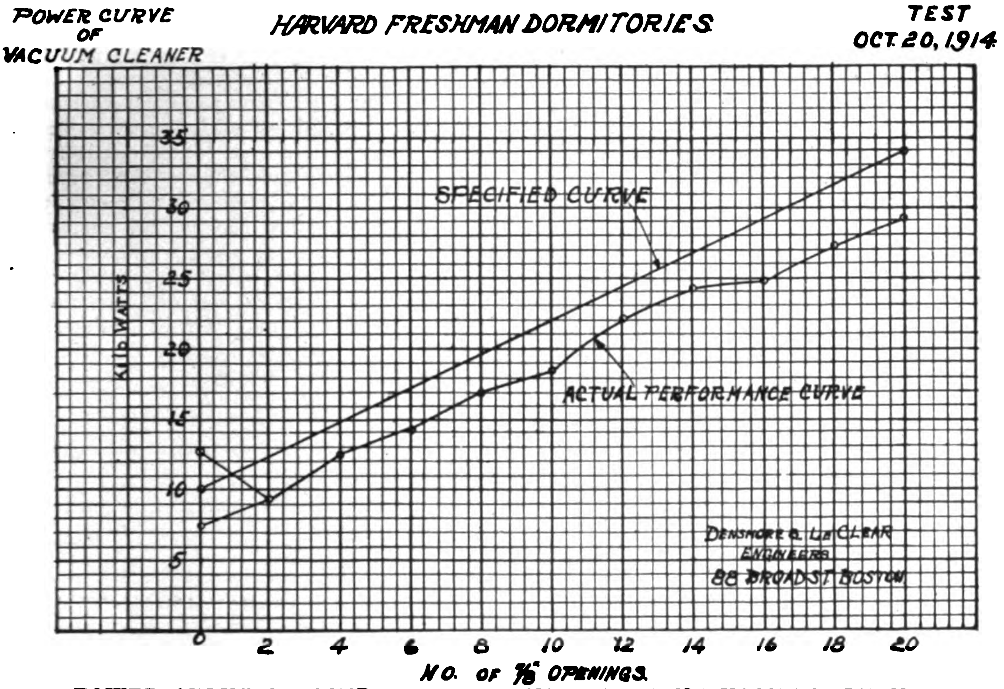
An interesting test was recently made of a vacuum cleaning installation at the Harvard Freshman Dormitories. These buildings, only two-thirds of which are shown in the accompanying illustration, are cleaned by one central plant of the Spencer turbine type. This test is of more than usual interest in view of the thorough manner in which the vacuum cleaner problem was investigated by the engineers at Harvard College before awarding the contract.

As setting a high duty standard, it was found, in the official test, that this plant maintained a little more than 2 inches of vacuum at the end of twenty 50-ft. lengths of 1½ in. hose, with ⅞-in. sharp-edged open orifices through ⅛-in. plate, with an electric current input of 1½ K. W. (about 1½ brake H. P.) per sweeper. The plant also maintained a little over 3 in. of vacuum at the end of twenty 50-ft. lengths of hose with similar ⅝-in. open orifices, with a current input of less than 1 H. P. per sweeper. The test was made with a standard 4-in. globe type vacometer.

An important point demonstrated by the test



SPENCER TURBINE VACUUM CLEANING INSTALLATION IN HARVARD FRESHMAN DORMITORIES.



POWER CURVE OF DOUBLE UNIT SPENCER TURBINE VACUUM CLEANER INSTALLED IN HARVARD FRESHMAN DORMITORIES.

was that the inherent characteristics of this equipment are such that the correct proportion of vacuum to volume at the end of the hose changes automatically as the operator changes from bare floor to carpet sweeping. It is well known that bare floor sweeping requires a different proportion of vacuum to volume of air at the end of the hose than with carpet sweeping.

In testing the uniformity of sweeping value delivered at all the buildings and at every outlet on the system, it was found that there was a variation in vacuum of less than ⅜-in. whether near the machine or 1,500 ft. away.

The separation test showed an efficiency of 98¾%, without the use of cloth bag screens or water. The accompanying chart shows the curve specified by the engineering authorities of the college. It will be noted that the performance curve just below it shows that this plant exceeded the requirements by a considerable margin.

The cleaner plant at the Harvard Freshman Dormitories was designed and installed by the Spencer Turbine Cleaner Co., Hartford, Conn.

Dinner to Pierce, Butler & Pierce Manager.

The transfer of George W. Crane as manager of the New York office of the Pierce, Butler & Pierce Mfg. Corporation to his new duties as assistant general sales manager, with headquarters at Syracuse, N. Y., was made the occasion of a testimonial dinner tendered Mr. Crane by his associates at the Hoffman House, December 11. Mr. Crane while acting as assistant sales manager for some time, has been in charge of the New York branch for the past six months. Covers were laid for twenty-four, including J. T. Duryea, president of the corporation. The toastmaster was John G. Kelley, manager of the plumbing department. At the conclusion of the dinner Mr. Crane was presented by President Duryea on behalf of the diners with a set of cuff links and a scarf pin.

Central Heating Trade Notes.

Alton, Ill.—An agreement has been reached between the Alton hot water heating system and its patrons. The patrons objected to paying for heat during September. The agreement reached was that the patrons should pay for that month, but that thereafter the company would give a rebate for the time the system was not in good working order.

Cleveland, O.—It is stated that the new $2,000,000 City Hall Building may be without heating facilities on its completion in 1916 if the City Council stands firm in its policy of refusing the Cleveland Electric Illumination Co. permission to extend its heating mains. The ordinance as passed by the Council had a purchase clause at-

tached, and this was refused by the illuminating company. Mayor Baker states that the city's heating plant will not be in a position to furnish heat to the downtown district within the next ten years.

Seattle, Wash.—Resolutions similar to those previously adopted by the Electrical Workers' Union, No. 77, noted last month, advocating the ownership and operation by the City of Seattle of a municipal steam heating plant, have been adopted by Steam Engineers' Union, No. 40. The plan as favored by the engineers is the construction of an initial plant in some specified district and the gradual extension of the system over the entire city.

North Yakima, Wash.—The local Electrical Workers' Union has gone on record as favoring the proposed franchise of the Central Heating Co. to engage in the business of furnishing electrical power. It is believed that if the company enters into a bona fide competition with the P. P. & L. Co., the city will derive some benefit from the competition, and should the present company eventually sell out, the city will have the first option to buy and operate a municipal plant.

Alton, Ill.—A thorough overhauling of the Alton hot water heating system is indicated by Assistant General Superintendent Myers of the Gas and Electric Co. The underground mains, it is stated, are in bad condition.

ADVERTISERS' INDEX

* Every other month.

TRADE AND MISCELLANEOUS NOTES

Coming Events.

January 20-22, 1915—Annual meeting of the American Society of Heating and Ventilating Engineers, at the Engineering Societies Building, 29 West 39th Street, New York.

Third Monday in Each Month—Meeting of the New York Chapter, American Society of Heating and Ventilating Engineers, Engineering Societies Building, New York (evening). No meeting in January. Subject for February meeting: "Methods of Measuring Air Velocities and Window Leakage."

Second Monday in Each Month—Meeting of the Illinois Chapter, American Society of Heating and Ventilating Engineers, in Chicago (evening).

Third Tuesday in Each Month—Meeting of the Massachusetts Chapter, American Society of Heating and Ventilating Engineers, in Boston (evening).

Deaths.

Joseph H. Glauber, general manager of the Glauber Brass Mfg. Co., Cleveland, O., died in Seattle, Wash., November 27, while on a business trip. His death was caused by pneumonia, following an operation for appendicitis. Mr. Glauber was 43 years old. He leaves a widow and four children, also a brother, H. Glauber, who is treasurer of the Glauber Brass Mfg. Co., and a sister. He was one of the organizers of the company with which he was associated and which was formed in 1890. He was also a past president of the National Association of Brass Manufacturers.

R. T. McCabe, father of D. E. McCabe, manager of the Chicago branch of the International Heater Co., and of J. B. McCabe of the Kewanee Boiler Co., died at the home of his son, D. E. McCabe, November 24, at the age of 82 years.

Charles A. Moore, president of Manning, Maxwell & Moore, New York, manufacturers of railway supplies and machine tools, died December 1 of heart disease, on board the steamer Rotterdam, while on his way to Naples. Mr. Moore was also associated with the Ashcroft Mfg. Co., the Hancock Inspirator Co., and the United Injector Co. He was 69 years old.

Col. Edward D. Meier, president and chief engineer of the Heine Safety Boiler Co., St. Louis, Mo., and a past president of the American Society of Mechanical Engineers, died at the home of his daughter, Mrs. William Schevill, in New York. His death was caused by hardening of the arteries and heart disease. One of the last and most important of Col. Meier's achievements in the field of engineering was the design and installation of 10,000 H.P. of boilers in the power house of the new Grand Central Terminal in New York. In 1913 Col. Meier accompanied the members of the mechanical engineers' society to Germany where joint meetings were held with the German society. Col. Meier was born in 1841. He obtained his rank of colonel in the Civil War. He organized the Heine Safety Boiler Company in 1884 and has been its president and chief engineer ever since.

Miscellaneous Notes.

Buffalo, N. Y.—According to an ordinance recently passed in Buffalo, the commissioner of public works is given authority to appoint chief engineers and assistants to have charge of the heating and ventilating plants and other machinery in the new high schools of Buffalo. These men will be under the immediate direction of the master mechanic in the bureau of buildings.

Boston, Mass.—A solution of the heating system problem at Deer Island has been effected by Acting Engineer Hackett of the Deer Island House of Correction, whereby the city, it is figured, will save $180,000 the first year and from $10,000 to $15,000 each year thereafter. This problem has puzzled the engineers of the Finance Commission for some time. It was determined some time ago that the antiquated heating system would have to be scrapped and a new one installed, which would centralize its power and operating cost. Mr. Hackett's plan is to dismember the boiler in the carpenter shop and another old one in the hospital and to install two 84-tube boilers, thus making three separate heating plants do the work of the five that are now in operation. The three separate heating plants will be connected in such a way that the plan will closely approach the system called for by the design of the city experts, and will cost $5,000, as against $180,000 which was the estimated cost of an entirely new plant.

Little Rock, Ark.—The Little Rock Gazette, in its issue of December 1, carries a double-leaded editorial calling attention to the cost of the heating and power plant at the State Hospital for Nervous Diseases, which, it is claimed, has cost $108,261, although the entire appropriation made for this work by the legislature was $75,000.

Buffalo, N. Y.—The new system of ventilation used on the surface cars of Buffalo has brought forth numerous expressions of satisfaction, according to President E. G. Connette of the International Railway Co. The system is used on the company's near-side cars. Under the old system, the cold air was admitted at the floor level of the cars where it passed over electric heaters into the cars and thence ascended vertically to the top where it was exhausted through numerous small openings. With the new method four of the upper windows on each side of the car are equipped with buttons which, when pressed to release the lock and pushed, give an opening of 4 in. to admit the outside air. In the rear of the car a louvre window is installed. The

conductors have been instructed to open all ventilating windows upon reaching the end of the line. They remain open unless the passengers close them, which is done by a slight push. The best way to gain the good will of car passengers during the winter, in Mr. Connette's belief, is to keep the patrons' feet warm and supply plenty of fresh air.

San Francisco, Cal.—The Panama-Pacific Exposition Company, having learned that the heating plant to be built for the Civic Center will not be completed in time to heat the Auditorium during exposition year, has asked the supervisors to allow it to use the lot at Polk and Grove Streets upon which to erect a temporary heating plant.

American Association of Commerce and Trade in Berlin, which is a member of the Chamber of Commerce of the United States, has inaugurated the publication of "Weekly Reports," giving information as to general conditions in Germany during the European war. The prime motive of this effort, it is stated, is to foster the commercial relations between the United States and Germany and the encouragement of mutual business relations. The association says it is firm in its conviction that after peace has been established, the American exporter will find a more ready market and fertile field for his goods in Germany than ever before, and it is the association's desire to maintain and encourage such trade. The "Weekly Report" will be sent regularly to those requesting it on application to the American Association, Equitable Building, Friedrichstrasse 59-60, Berlin, Germany.

Racine, Wis.—The superintendent of schools in Racine is preparing a special course of instruction in heating and ventilating for the janitors of the public schools in that city, which they must take to hold their positions. Instruction will also be given in the reading of air, temperature and humidity recording instruments.

Mobile, Ala.—As the result of a discussion before the Board of School Commissioners, temporary heat will be supplied to the three new schools in Mobile, The Russell, Semmes and Old Shell Road, and a committee of three will be appointed to look into the merits of the different kinds of heating systems and report by June 1, 1915. Stoves will be installed in these schools for the present. A bid of $7,000 for the heating of the three schools was received from L. J. Leahy. The postponement of the award followed the reading of extracts from medical journals favoring natural ventilation.

Chicago, Ill.—In connection with the trial of a street car conductor in Chicago for assault and battery in putting Alderman Ellis Geiger off a North Street surface car under the "back platform" rule, one of the witnesses was Dr. E. V. Hill, of the ventilating division of the city health department, who exhibited a culture of bacteria

made from a sample of air taken in a North State Street car, in which there were about 60 passengers, on the day following the Geiger incident. The culture showed 190 different colonies of germs, without counting the germs causing diphtheria, tuberculosis, scarlet fever and such diseases which, he said, he could not reproduce in a test of this sort. Dr. Hill said that there are about 1,800 of the surface line cars of the Monitor type, which is the type used on North State Street, which daily violate the city ordinances in regard to ventilation. These cars have a flat top raised about 10 in. from the body of the cars, with rows of little windows about the top. These are sometimes opened on the theory that they give ventilation, but, according to Dr. Hill, the air coming through these windows circulates only in the top of the car and even passengers standing in such cars do not obtain any noticeable benefit from such ventilators. Now that the ventilation inspectors have practically completed their work in connection with the inspection of the moving picture theatres, Dr. Hill says that they will take up the street car ventilation problem immediately after the first of the year.

Dr. William F. Colbert was the principal speaker before the Co-operative Engineering Society of Mechanics Institute in Rochester, recently, his subject being "Furnace Heating." Dr. Colbert discussed the subject from the standpoint of engineering efficiency, outlining many of the experiments which are carried on under his direction in the scientific laboratory of the Sill Stove Works, of Rochester.

Buffalo, N. Y.—Measured by the standard of the number of persons given employment, the city of Buffalo in 1913 was first in New York State in the manufacture of heating apparatus. The figures are contained in a statement issued by State Labor Commissioner James M. Lynch in connection with the second edition of the industrial directory.

Detroit, Mich.—The heating plant at the Central High School is in urgent need of remodeling, according to Jay R. McColl, consulting engineer of the school board. The school board asked for $70,000 last Spring to remodel the system, but the estimators allowed only $25,000. The present system is about 20 years old.

Washington, D. C.—More deaths are occasioned by improper ventilation of railroad coaches and waiting rooms than by train accidents, is one of the statements contained in a report of the committee on railway service and accommodation of the Interstate Commerce Commission, recently published. "The noxious gases," continues the report, "that fill sleeping cars, in connection with the peculiar character of the dust therein, are most conducive to germ breeding where proper ventilation is lacking." While giving the railroads credit for progress in lighting and heating their coaches, the committee says that the lighting, heating and ventilation of waiting and toilet rooms is deplorable. The common form of toilet facilities on trains is denounced as not only "uncleanly and an

THE HEATING AND VENTILATING MAGAZINE

1123 Broadway NEW YORK February, 1915

Heat Loss Test in a 200-Room Building

Reliability of Well-Known Formulas Borne Out in Experiments at University College, London.

A report of a two-day test of the loss of heat from the old college building at the University College, in London, was made by C. H. Avery at the recent summer meeting of the Institution (British) of the Heating and Ventilating Engineers. The purpose of the test was to check the orthodox method of calculating heat losses and to ascertain how the results of calculations compared with the practical results of experiment. The observations were made during the week end of January 24-25, 1914, on the whole of the old college building, containing some 200 rooms.

The heating apparatus in this building, Mr. Avery stated, is more or less continuously in operation during the winter months. It is the custom to bank the fires during the night at about 8 p. m. and start them up again in the morning at about 7 a. m. This may be taken as representative of the ordinary procedure in the great majority of buildings.

It was thought, therefore, that if a comprehensive series of observations was taken of the temperature in each room, the actual amount of heating surface installed, and the temperature of each portion, the result would form a valuable indication as to whether the coefficients in general use were satisfactory.

The apparatus was operated during this test exactly as in every day use, but in order that any necessary observations might be taken without hindrance it was necessary to get control of the apparatus during the week-end, when there were no students or professors in the building.

A continuous record was kept of the outside temperature for the previous fortnight and during the test. The temperature of all heating surfaces was measured by inserting thermometer cups into the pipes and, in some cases, by running water from air cocks onto the bulbs of thermometers. In most cases the heating surfaces in this old installation consists of an inadequate amount of 3-in. and 4-in. pipe. The boilers, for the most part, are old-fashioned and made of wrought iron. In some cases, the boilers have been replaced by modern sectional boilers.

Every room in the building was carefully measured and the calculations made on the orthodox basis with considerable care.

During the test and for 24 hours before the observations were commenced the boilers were worked uniformly to a

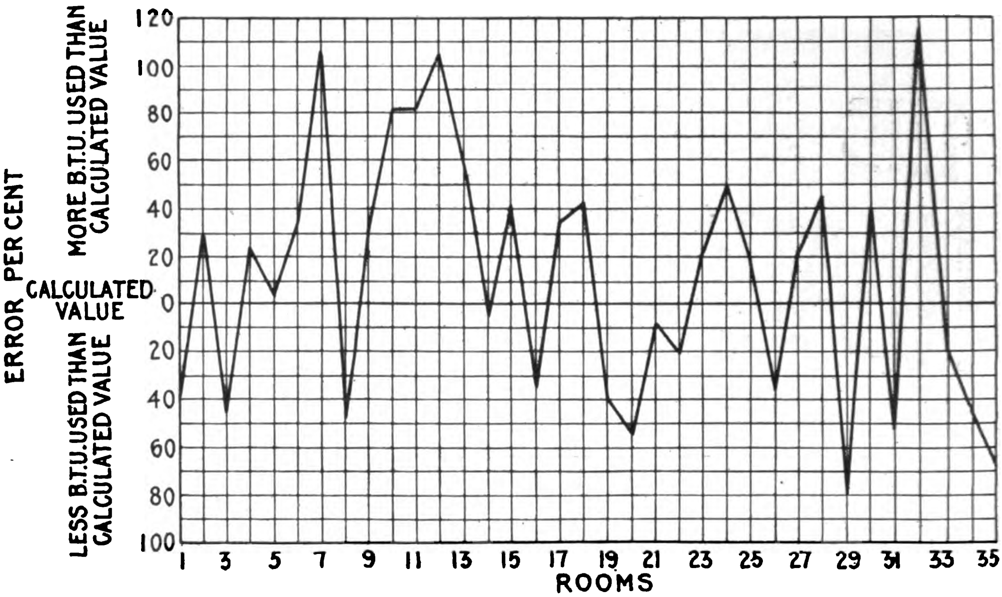


FIG. 1.—COMPARISON OF THEORETICAL AND ACTUAL HEAT LOSSES AT UNIVERSITY COLLEGE BUILDING, LONDON, SHOWING PERCENTAGE OF ERROR.

high temperature of about 180° F. on the flow pipe. The outside temperature had been fairly constant for some time before the observations were taken, thus reducing the temperature of the walls to a uniform value. Careful observations were taken at intervals of the interior temperatures in each room. These temperatures were found to be fairly constant through the week-end. Records were kept of these and the rise of temperature calculated.

Calculations of heat loss were in the first place made for the orthodox difference of 30° F. (which is English practice), with two interchanges of air per hour. Each of these heat losses was then reduced in the proportion of 30° to the actual rise observed, thus obtaining the theoretical heat loss under the

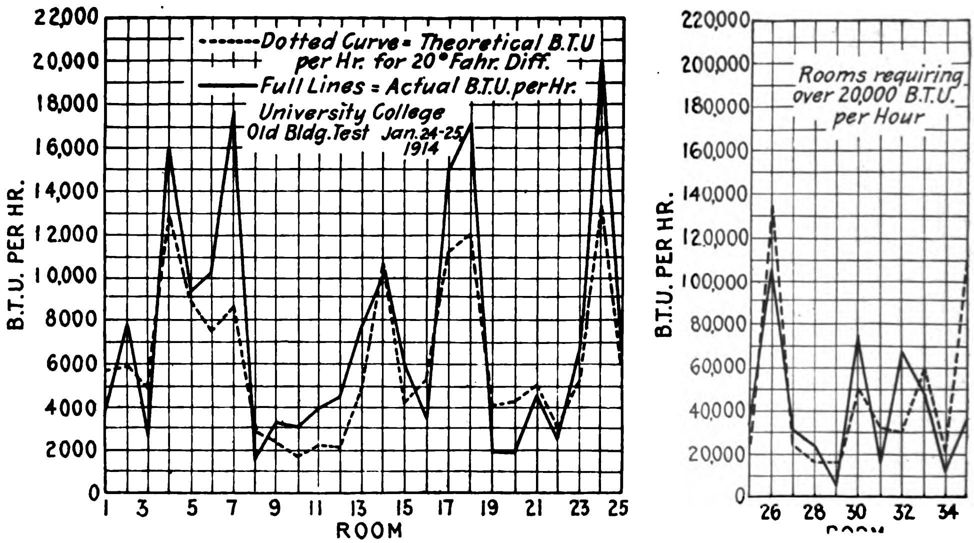


FIG. 2.—COMPARISON OF THEORETICAL AND ACTUAL HEAT LOSSES, SHOWING DIFFERENCES IN B.T.U.

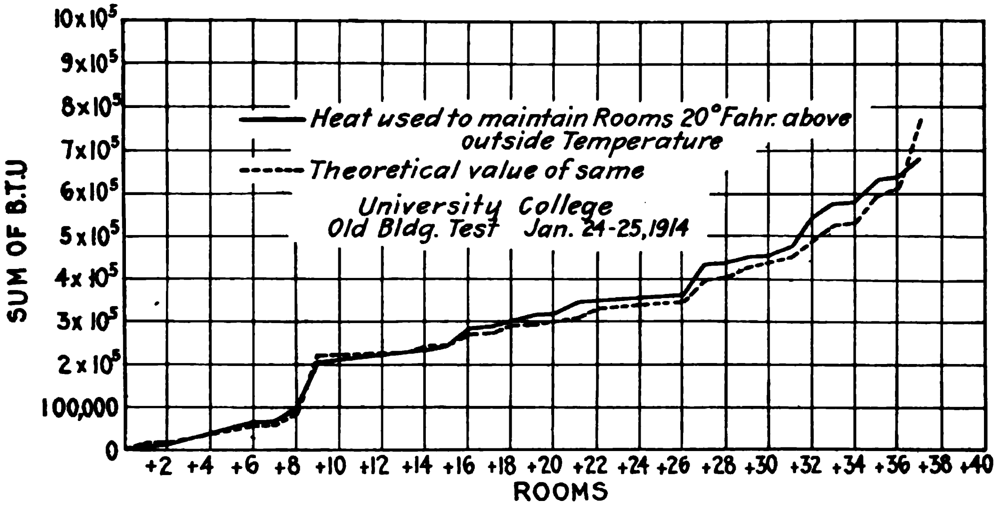


FIG. 3.—SUM CURVES OF THE HEAT REQUIRED AND CALCULATED FOR ALL THE ROOMS.

actual conditions observed. This figure was compared with the heat loss from the pipes, as calculated. Each length of each size pipe was measured with a tape, and the temperature of each length was also observed and the heat loss calculated from standard coefficients.

We have thus means of comparing the heat theoretically lost from the building with the heat given off by the hot pipes to the building. This comparison is plotted in Fig. 1. It will be noticed that each point on the horizontal axis of co-ordinates has reference to one particular room. The irregularity of the curves is partly due to the widely different sizes of the various rooms and the author also states that no account was taken of the accession of heat from adjacent rooms, which, he says, would have a bearing on these variations.

The author also showed two sum curves (Fig. 3) of the heat required and calculated for all the rooms. These curves give a much better idea of the relation between practice and calculation. It will be seen that the agreement is fairly close. This does not mean, said Mr. Avery, that the figures are theoretically correct but only that they served as a reliable guide in practice.

The speaker also pointed out that no tests were made of the actual interchange of air in the rooms; it was simply assumed to be twice per hour. Any large variation from this figure would, of course, vitiate the results.

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*EDITOR'S NOTE.—In another portion of the report, Mr. Avery refers to the formulas of Rietschel, Barker and Carpenter. In the Rietschel formula the heat lost through the walls, etc., in B.T.U. per hour is equal to the net area of surface, multiplied by the temperature difference, multiplied by a coefficient K, depending on the character of the building material. This is for continuous heating. When the space is intermittently heated an addition is made to the heating figures. A room, for instance, which requires W, B.T.U. under constant conditions of temperature, if left unheated for n hours during every 24 hours, will require an additional provision as follows:

$$Z = \frac{0.0625\ (n-24)}{z} W,$$

where Z equals hours of heating up. A further allowance is made for more than one air change per hour.

The Barker formula, allowing for two air changes per hour, is given as: Heat loss = actual glass area + (outside wall area ÷ 4) + (ceiling area ÷ 6) + (floor area ÷ 10) + (inside wall area ÷ 8) + (contents of room ÷ 30). For the interrupted heating Mr. Barker allows 15% of the total B.T.U.

The well-known Carpenter formula which Mr. Avery quotes is as follows, allowing for two air changes per hour: Heat loss = 1.5 [G + (OW ÷ 4) + (IW ÷ 8)], OW representing outside wall or roof surface and IW, inside wall surface. The 1.5 accounts for the two air changes per hour. No reference is made to any additions for intermittent heating, but the results obtained with this formula, as used by Mr. Avery, agreed fairly closely with those of Rietschel and Barker, after allowances had been made in the two latter for heating up.

LABORATORIES OF THE LUBIN MFG. CO., AT BETZWOOD, PA.

Air Conditioning in a Moving Picture Laboratory

EQUIPMENT OF PLANT OF THE LUBIN MANUFACTURING COMPANY.

The problems of photography presented in the reproduction, from the master negative, of moving-picture films, are the same with which every amateur is familiar, but in addition there are many more which result from large scale production and the special nature of the industry.

The Lubin Manufacturing Company in its plant at Betzwood, Pa., has made an effort to bring under control all the factors affecting their product, and neither time nor expense has been spared to make it the most complete photographic laboratory in existence.

An important phase of their problem, of interest to engineers, is represented in the elaborate system of air conditioning designed to bring atmospheric conditions under control. While it is true of almost every series of industrial processes that one or more can be accomplished to best advantage at times when certain atmospheric conditions prevail, it is especially true in the fabrication of moving picture films on account of their sensitiveness to temperature and humidity.

DIFFERENT PROCESSES IN MAKING MOVING PICTURE FILMS.

The major processes entering into the production of a moving picture film, are:

1. Perforating, in which the edges of the film are punched to fit the standard projecting lanterns.

2. Printing, in which the various scenes are printed from the master negative upon the unexposed film. This, of course, is done mechanically.

3. Developing, in which the films are reeled upon frames and the whole dipped into the developing bath, etc.

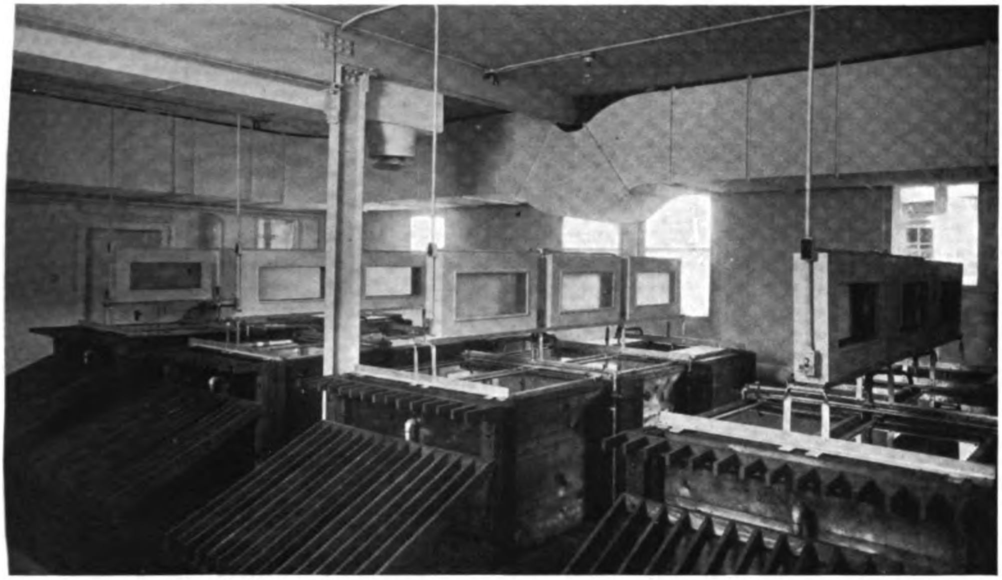
4. Washing, in which the films are subjected to a rather protracted spraying of fresh cold water.

5. Drying.

6. Joining, in which the various scenes, leaders, etc., are assembled and joined to form the continuous film.

DIFFICULTIES DUE TO ATMOSPHERIC CONDITIONS.

Among the evils due to atmospheric influences, are: 1. The tendency of the film to curl if subjected to too high a temperature. It is obvious that if this occurs prior to or during the perforating or printing operation or during the drying, the picture when projected upon the screen will be distorted. 2. Premature erosion of negatives and lack of clearness of the finished film, due to the presence of dust in the air. 3. Uncertain rate of drying, especially during summer, owing to the low temperature at which drying must be carried on. 4. Unfavorable working conditions for employees in the dark rooms, especially in hot weather, owing to the production of much heat in the operation, which necessitates rapid ventilation and consequently in much dirt being brought in. Under certain conditions production is



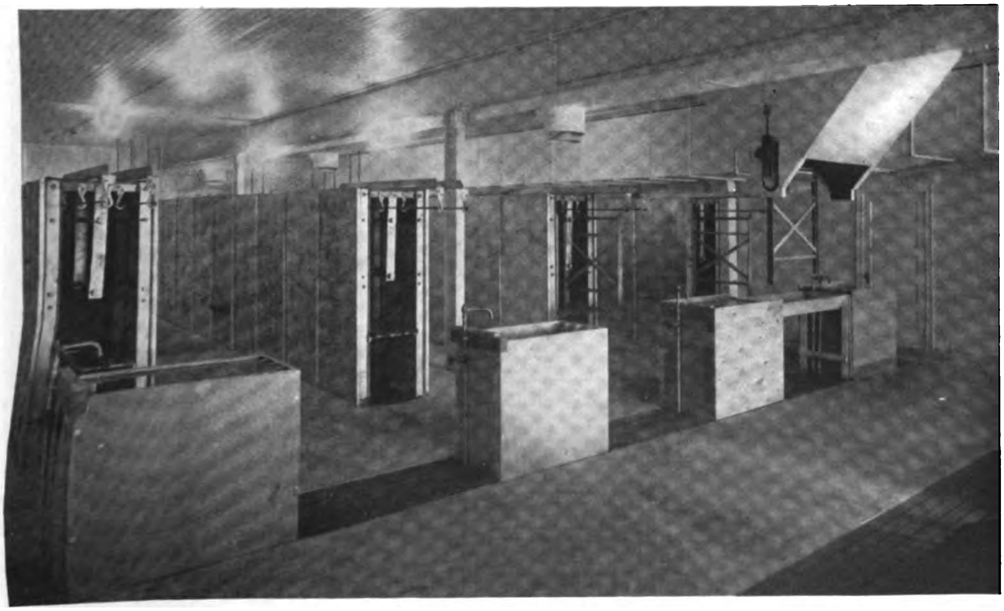
PART OF DEVELOPING ROOM, LUBIN MOVING PICTURE LABORATORY.

greatly curtailed if not completely stopped.

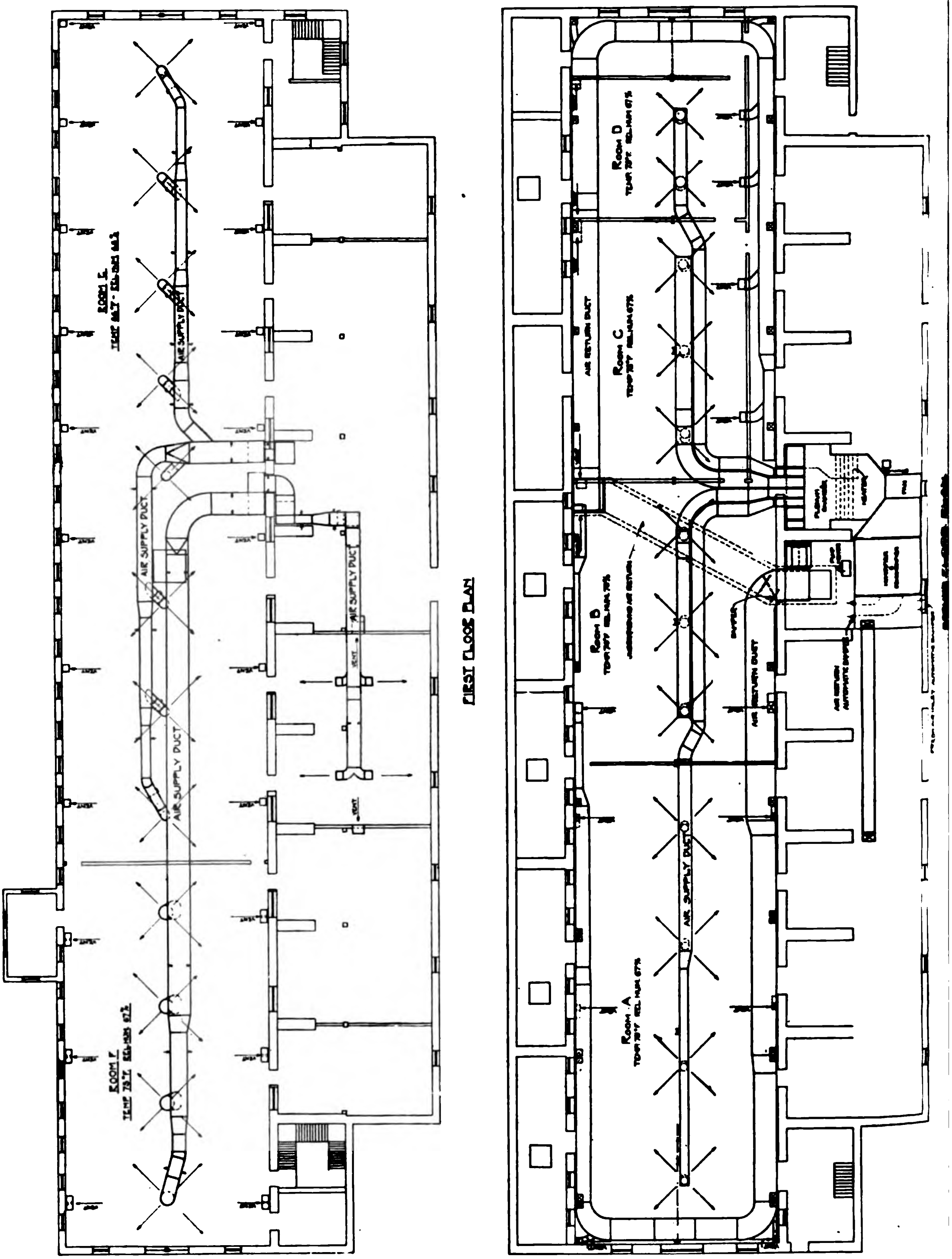
The complete adaptability of air conditioning equipment to such conditions is at once apparent, and in fact has actually eliminated the troubles enumerated.

SYSTEM OF VENTILATION AND AIR CONDITIONING.

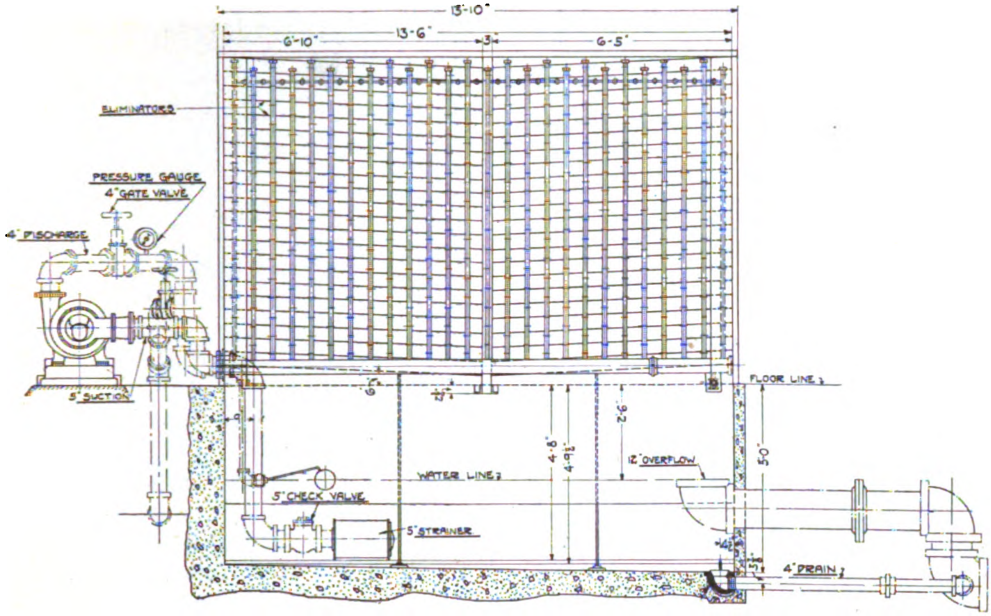
In brief the system of ventilation and air conditioning includes an air washer used as a humidifier during a portion of the year and as a de-humidifier and cooler the remainder; a fan drawing air through



WASHING ROOM, LUBIN MOVING PICTURE LABORATORY.



GROUND AND FIRST FLOOR PLANS OF PLANT OF LUBIN MFG. CO., SHOWING LAYOUT OF AIR CONDITIONING SYSTEM.



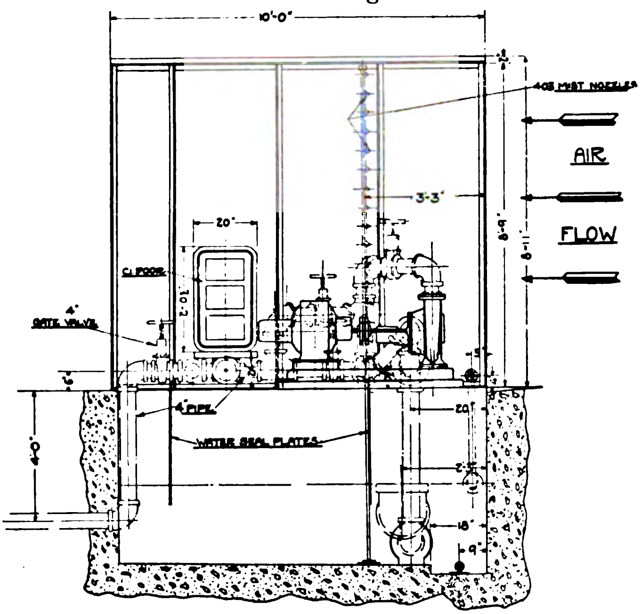
ELEVATION

DESIGN OF AIR WASHER AT PLANT OF LUBIN MFG. CO., FOR HUMIDIFYING AND ALSO FOR DEHUMIDIFYING AND COOLING THE AIR.

the air washer and discharging through a heater and by-pass into a plenum chamber from which separate supply ducts are taken to the various rooms. Air recirculating ducts are provided, which discharge into a suction chamber, at which point the requisite amount of fresh air is introduced to the system, the mixture passing into the washer and so completing the cycle. Thermostatic temperature regulation is also provided.

The air washer used, furnished by Warren Webster & Co., Camden, N. J., is known as the "Type B," a design especially adapted to the use of a refrigerating medium for cooling or de-humidifying air. This apparatus is built of heavy gauge galvanized American Ingot iron and has a capacity of 50,000 cu. ft. of air per minute. The air washer consists of a casing 8 ft. 11 in. high, 13 ft. 10 in. wide and 10 ft. deep, forming the spray chamber and enclosing an eliminator and spray system, the whole set over a concrete tank.

The air is brought into contact with



END ELEVATION

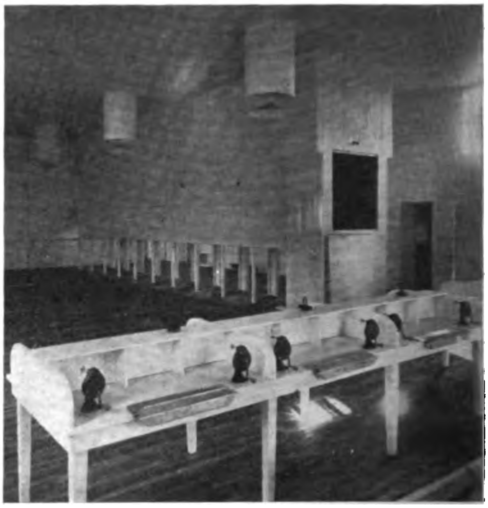
END ELEVATION OF AIR WASHER FOR PLANT OF LUBIN MFG. CO.

the spray water in the form of a finely divided mist and fog issuing from a series of brass spiral mist nozzles uniformly spaced over the entire spray chamber area. These nozzles discharge 500 gals. of water per minute at 20 lbs. pressure against the direction of air flow. This arrangement, with the long spray chamber, was made to secure perfect contact between air and water, a feature of great importance in view of the use of cold artesian well water as the refrigerating medium in this case.

After contact with the sprays the air passes into the eliminator of the air washer, where it is deflected four times to remove all entrained moisture. The eliminator consists of a series of baffles spaced about 3 in. on centers, with lips on each to increase the separating efficiency. The wide spacing of the baffles renders the entire eliminator accessible for cleaning and inspection.

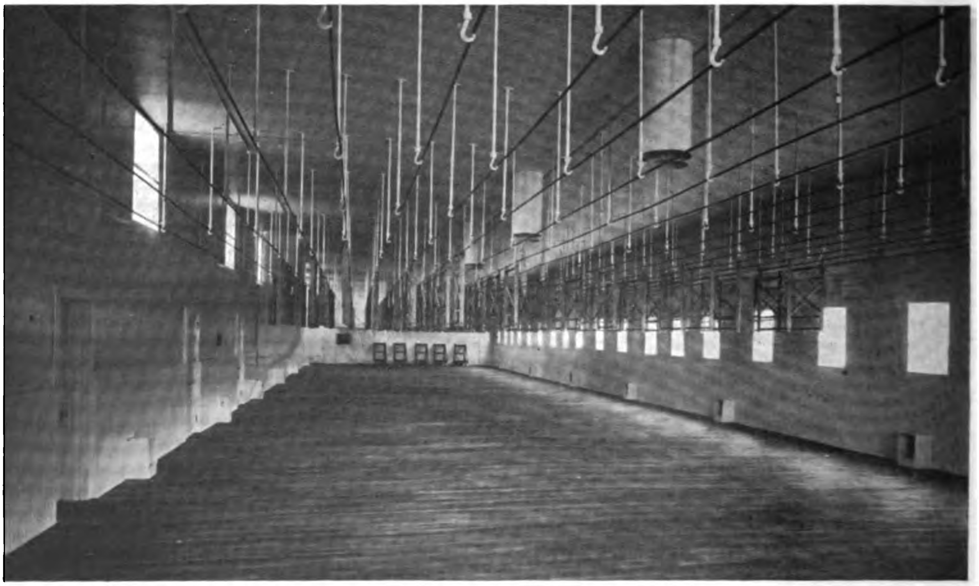
The spray water, after use, falls into the concrete tank, whence it is recirculated as required, the excess passing out the overflow to sewer.

For maintaining the required pressure of 20 lbs., on the spray nozzles, there is provided a Platt single-suction centrifugal pump, direct-connected by means of a flexible coupling to a 20 H.P., 220 volt, 2-phase, 60-cycle Westinghouse motor, all mounted on a cast-iron base plate with oil rim around same. Ample safety margin was allowed in this as in all other motors owing to the continuous service required at certain times of the year.



JOINING ROOM, PLANT OF LUBIN MFG. CO., SHOWING CONVEYOR FROM WASHING ROOM TO DRYING ROOM.

The fan is a three-quarter housing Sirocco unit, driven, through a silent chain, by means of a 35 H.P. motor of make and characteristics the same as the air washer motor.



DRYING ROOM, PLANT OF LUBIN MFG. CO.

The heater is built in two parts, one for the dry room and the other for the balance of the plant.

The air supply duct system is run overhead, the duct for each room being carried through the center of same. Outlets are taken off the bottom of the ducts and the air is discharged against adjustable, conical diffusers.

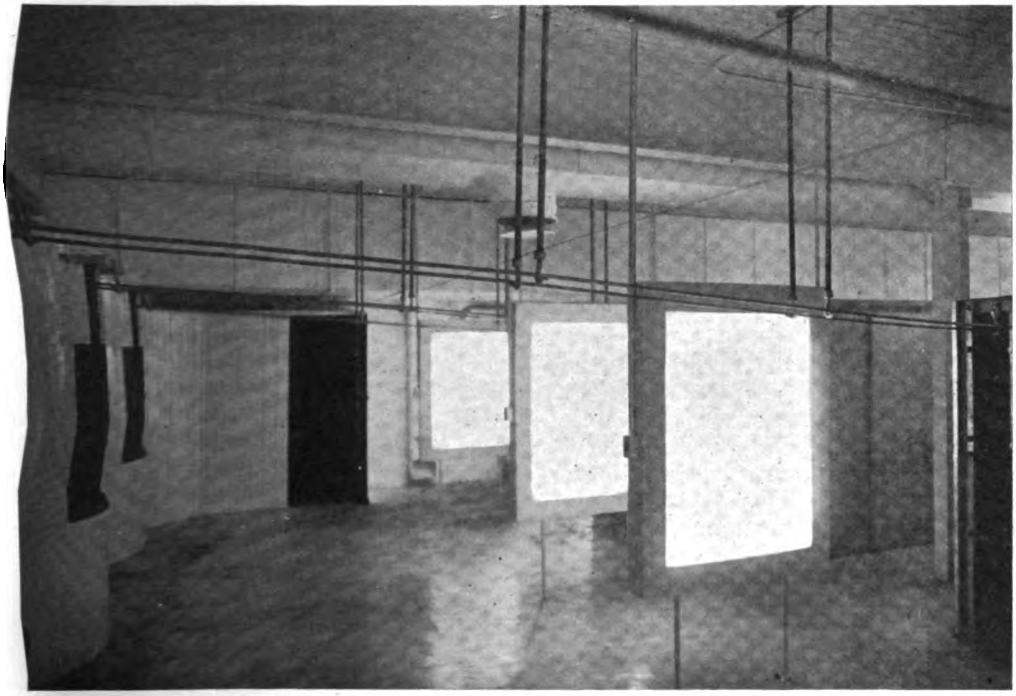
Rooms are vented through outlets near the floor, each outlet being provided with hand dampers. The supply ducts, in addition to hand dampers, are provided with mixing dampers at the plenum chamber, automatically controlled by Johnson thermostats placed in each room. Thus the temperature and rapid displacement of the air in each room is maintained constant.

Among the rooms treated are: The perforating room, printing room, developing room, washing room, dry room, titles room, joining room, negatives room. Each of these rooms is maintained constantly at different temperatures and relative humidities. In some rooms it was found necessary to supply an air volume effecting an air change of more than 20 times an hour in order to maintain the desired temperature during the warmest summer weather.

When the outside air condition exceeds a certain pre-determined point, cold well water of the required volume is circulated in the air washer, automatic control of the cold water injection being effected thermostatically. In addition, appromimately 95% of the air is recirculated, provided the outside wet-bulb temperature exceeds that of the return air, otherwise all air is taken from outside. When, however, the outside wet-bulb temperature is below the predetermined point, the spray water is entirely recirculated and a portion of the air recirculated, varying from 10%, in coldest weather, to 45%. The mixture of fresh and return air is automatically controlled by dampers operated thermostatically.

This method of operation secures the utmost economy of cold water in summer and of steam for heating and humidifying during the colder seasons.

The entire air conditioning equipment was designed by Warren Webster & Co. in conjunction with Edward L. Simons,



INSPECTION ROOM, PLANT OF LUBIN MFG. CO.

consulting engineer for the Lubin Company. Bowers Brothers & Co., Philadelphia, Pa., were the contractors and the results of their efforts are worthy of special mention as the workmanship is considered practically perfect to the smallest detail.

The Lubin Manufacturing Company is to be congratulated on their enterprise, which, happily, has resulted in greater speed, facility, economy and quality of production.

The installation is of special interest to both engineers and manufacturers in that it is a recognition of the important bearing which atmospheric conditions have upon industrial processes generally, and an extension of the ever expanding field for the application of air conditioning apparatus.

A Study of Heating and Ventilating Conditions in a Large Office Building

C. E. A. WINSLOW* AND G. F. MAGLOTT.

(Presented at the annual meeting of The American Society of Heating and Ventilating Engineers, New York, January 20-22, 1915.)

The progress of the art of heating and ventilation has been seriously retarded by the gap which unfortunately often exists between design and operation. Excellently planned systems may fail on account of changes in conditions of occupation or carelessness in upkeep and management; while, on the other hand, operation sometimes reveals shortcomings in design which should be instructive in the planning of future installations. Careful studies of the actual results obtained in practice from the operation of heating and ventilating plants are none too common. The results of such a study of a large business office building in New York City may therefore be of some interest. The authors had the advantages of the advice of Mr. D. D. Kimball as consultant in the course of the investigation.

THE SYSTEM OF TEMPERATURE CONTROL.

The building is heated in the main by direct steam radiation although certain rooms on the lower floors are in part indirectly heated by plenum air supply. The steam in the heating coils is maintained under ½-lb. pressure against a 1-in. vacuum.

The radiators in certain sections are hand controlled, in other sections thermostatically controlled. Of the workrooms examined by our inspectors, 65 had hand-control and 46 thermostatic control; of the offices 39 had thermostatic control and 82, hand-control. The thermostats in use are of an old type and are in a state of general disrepair. Of 213 thermostats individually examined, 110 or 52% were not controlling their radiators. A considerable part of the trouble was obviously due to interference with the instruments on the part of clerks who, dissatisfied with existing temperature conditions, have attempted to set them right without understanding the mechanism with which they were tampering.

TEMPERATURE AND HUMIDITY CONDITIONS IN OFFICES AND WORKROOMS.

During the period between January 25 and May 17, 1914, our inspectors made 2,045 determinations of temperature and humidity by the use of the sling psychrometer in practically all the offices and workrooms ocupied by the company.

The humidity results were not particularly significant, merely showing that as usual the indoor humidity varied directly with the outdoor temperature. During most of February and the first half of

*Curator of Public Health, American Museum of Natural History; Chairman New York State Commission on Ventilation.

March the humidity in the building was under 30% of saturation, in the last half of March and in April it fluctuated between 30 and 40% and in May it rose above 40%.

The temperature data were of course of much greater practical importance. The average weekly temperature for the building never fell below 69° F. during the whole period studied. Out of the 16 weeks covered by our investigation, four showed averages between 69° and 70°, ten averages between 70° and 72°, one an average of 73.5° and one an average of 75°.

Fifty-eight per cent. of the individual rooms studied showed a temperature of 71° or less; thirty-four per cent. were between 72° and 75°; nine per cent. were between 76° and 81°. The distribution of observations is shown graphically in Fig. I, the hand controlled and thermostatically controlled rooms being plotted separately. For comparison we have included the distribution of 143 temperature records made by Professor Baskerville and the senior author in a well managed public school, School 33, the Bronx, New York City.

The curves in Fig. I bring out two points; first, that the office building as a whole is greatly overheated as compared with such a constant low temperature as is maintained in School 33 (in which 97% of all records were under 72° F.); and second, that overheating is even slightly greater in the thermostatically-controlled than in the hand-controlled rooms. The moral is that overheating is likely to be general either where hand-control alone is relied upon or where a thermostatic system has been allowed to fall into disrepair.

In addition to the sling psychrometer determinations we obtained continuous records of temperature by means of Tycos thermograph in twenty-five different rooms, usually for a two weeks' period in each room. The record for one of the most overheated rooms in the building is reproduced in Fig. 2 to show how bad conditions may become. This particular room had three thermostats, all in bad condition; and for a period of twenty-one days, between February 28 and March 24, the temperature never once fell as low as 70° F. during working hours, and was usually in the neighborhood of 80°.

THE SERIOUSNESS OF OVERHEATING.

It is perhaps hardly necessary before this society to dwell upon the importance of such conditions of overheating as those recorded. It has again and again been shown that the most serious of the effects experienced as a result of bad air conditions are due not to chemical poisons, but to high temperature. The recent studies of the New York State Commission on Ventilation furnish striking evidence of the bad effects of high temperatures upon the heat-regulating system of the body as shown by rise in body temperature and fall in blood pressure and by the decrease in mental and physical work done in overheated rooms. There can be no doubt that the clerks exposed to such conditions as those observed are injured in health and hampered in efficiency thereby.

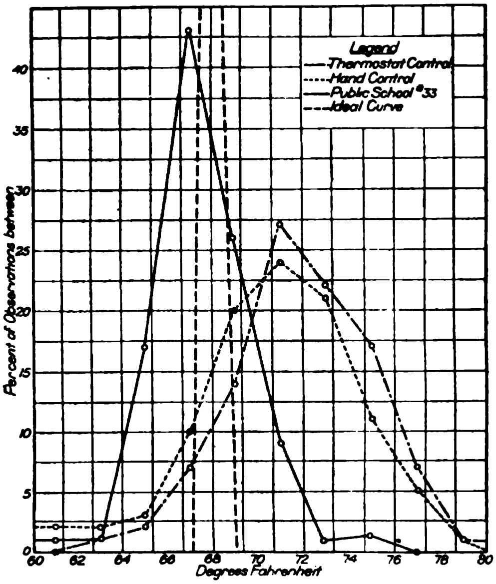


FIG. 1.—TEMPERATURE OBSERVATIONS IN LARGE NEW YORK OFFICE BUILDING FROM JANUARY 25 TO MAY 17, 1914.

THE VENTILATING PLANT.

Considerable areas in the sub-basement and basement and a few company offices and workrooms on the first, second and third floors are equipped with plenum air supply. The rest of the building has either an exhaust system alone or no artificial ventilation at all. About 44%

of the workroom area comes under the latter head.

It may be generally assumed that when an office or workroom is so crowded that the floor area is less than 200 sq. ft. per capita, efficient artificial ventilation will be necessary. Of all the workrooms occupied by the company we found that 90% have less than 200 sq. ft. per capita, 78% less than 100 sq. ft. and 31% less than 50 sq. ft. The provision of only 56% of the workrooms with any artificial ventilation at all is therefore the first serious defect indicated.

The 56% of the workroom area which does have artificial ventilation depends almost wholly upon the exhaust system. This system consists of six separate shafts, one of which is much larger than the others. Each shaft is of graduated cross section carried up through the building to a fan room at the roof. Two of the shafts (IV and VI) are lined with sheet metal, the others are of plaster on metal lath carried on light steel shapes. All the fans are of the propeller type operated by direct connected electric motors, controlled by rheostats. All the fans were found to be operated at a reduced speed in accordance with orders of the chief electrician.

The general engineering data obtained in regard to the operation of these ducts are indicated in Table 1. We have estimated the probable population on each shaft in 1,925 as indicated by the past growth of the business and have tabulated the work done by the fans as at present operated and when operated under our direction at full speed.

Our results indicate that with the present population all the shafts but II are exhausting over 30 cu. ft. per capita and may be considered satisfactory. Shaft III, however, is close to the limit and Shaft II is already **inadequate.**

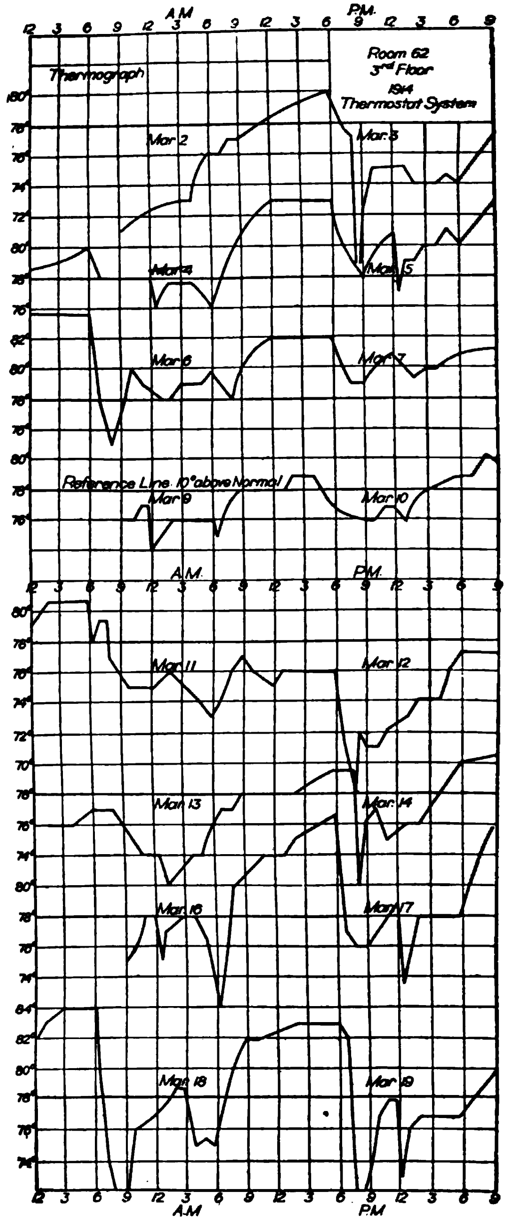


FIG. 2.—TEMPERATURE RECORDS FOR ONE OF THE MOST OVERHEATED ROOMS, NEW YORK OFFICE BUILDING.

ROOM REGISTER OPENINGS AND PER CAPITA AIR SUPPLY.

The most serious defect of the ventilating system we found to lie in the generally inadequate room register openings which in many cases prevent the main ducts from effecting a change in the rooms which need it most. In order to remove the standard air quantity of 30 cu. ft. (per minute) per capita with the register velocities practically attainable it is necessary to have a register area of about 0.1 sq. ft. per capita. A detailed study of 74 workrooms showed that in 23 cases or 31% the register area was less than 0.075 sq. ft. per capita, in 12 cases or 16% between 0.075 and 0.125 sq. ft., in 16 cases or 22% between 0.125 and 0.200 sq. ft., in 8 cases or 11% between 0.2 and 0.3 sq. ft., in 13 cases or 18% be-

TABLE I.—SHAFT AND FAN CAPACITIES.

	Shaft No.					
	I	II	111	IV	V	VI
Population—						
Present	437	533	411	483	25	1,100
1925	700	870	670	790	40	1,810
Shaft area top, sq. ft	27.3	16.2	16.5	18.0	11.7	70.5
Present speed*—						
R. P. M.	368	334	240	225	476	112
Velocity ft. per min	475	500	485	1,100	410	733
Q	12,950	8,100	8,000	20,000	4,800	51,700
Full speed—						
R. P. M.	438	450	418	268	600	160
Velocity ft. per min	570	740	795	1,310	490	970
Q	15,500	12,000	13,100	23,600	5,700	68,300
Q per capita—						
Present	36	23	32	49	228	62
1925	22	14	20	30	142	38
Rated or theoretical, Q	20,000	25,000	15,000	37,000	5,000	75,000
Rated H. P.	5	5	5	6¼	1¼	11½
Diameter fan, inches	48	48	48	72	30	120
Capacity of shaft*—						
Total Q	21,800	13,000	13,200	14,400	9,400	56,200
Q per capital, 1925	31	15	20	18	235	31

*Figures based on a velocity of 800 ft. per minute as limited by type of fan. With a different type of fan the capacity of the shaft would be doubled.

tween 0.3 and 1.0 sq. ft., and in 2 cases or 3%, over 1.0 sq. ft. This means that the relation of register area to room population under present conditions of occupancy has become quite haphazard, that 31% of the workrooms have less than the proper allowance of register area while others have far too much.

Determination of the actual flow of air at the exhaust registers was made with the anemometer on 148 different occasions in one or another of the fan-ventilated workrooms, practically all of them being covered at least once. Ten rooms or 7% showed a negative pressure (the supposed exhaust acting as a supply), 47 or 32% showed less than 10 cu. ft. per capita, 32 or 22% between 10 and 20 cu. ft. per capita, 18 or 12% between 20 and 30 cu. ft., 11 or 7% between 30 and 40 cu. ft. and 30 or 21% over 60 cu. ft. per capita. Thus in 89 cases out of 148 or 61% the air exhaust was quite inadequate, being less than 20 cu. ft. per capita, in 29 cases or 19% it was between 20 and 40 cu. ft., a reasonable amount; while in 30 cases or 22% it was over 40 cu. ft., or far in excess of necessary requirements.

It was interesting to note that by far the worst conditions were found upon the upper floors. In the lower stories the exhaust was usually adequate, while in the upper stories the amount of air drawn out progressively decreased. On two of the shafts the suction above the seventh and eighth floors respectively was either negligible or was replaced by a positive outflow of air into the room, vitiated air from the lower workrooms being forced out into the upper ones (Fig. 3).

DETERMINATION OF CARBON DIOXIDE.

In order to measure the actual extent of air change within the offices and workrooms we made 228 determinations of carbon dioxide, using the standard Peterson-Palmquist apparatus. Of the 228

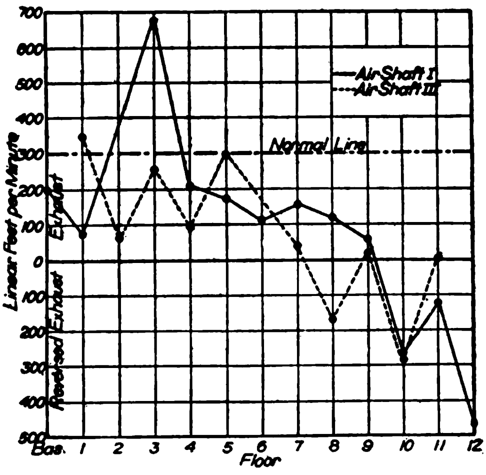


FIG. 3.—DETERMINATIONS OF AIR FLOW AT EXHAUST REGISTERS.

records 58% were below 9 parts per 10,000, 32% between 9 and 12 parts, and 12% over 12 parts, indicating that air change was inadequate in over 40% of the cases studied.

As shown in Fig. 4, the worst results were of course in the worst crowded rooms. It will be noted that taking 8 parts of carbon dioxide as a reasonable limit only one excessive value was recorded in a room with over 200 sq. ft. of floor space per capita.

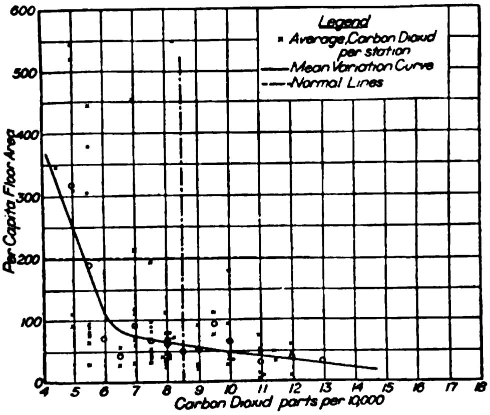


FIG. 4.—CARBON DIOXIDE MEASUREMENTS IN OFFICES AND WORKROOMS OF NEW YORK OFFICE BUILDING.

Fig. 5 shows the relation between carbon dioxide and air movement at the register openings and it will be noted that only one high value was obtained where the air exhaust was over 30 cu. ft. per capita. Mean carbon dioxide values increased progressively in passing upward from floor to floor.

The actual air conditions in the workrooms were of course controlled not only by the exhaust system, but also by the extent to which windows were kept open. In Fig. 6 the observed carbon dioxide values are plotted against the area of open window space in the respective work-

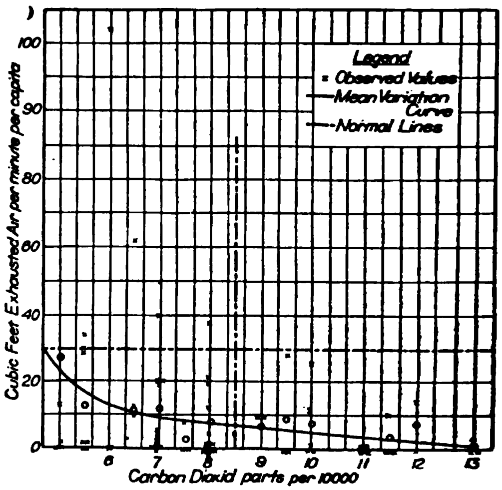


FIG. 5.—RELATION BETWEEN CARBON DIOXIDE AND AIR MOVEMENT AT REGISTER OPENINGS.

rooms at the time expressed in square feet per capita. The relation is seen to be a very close one. With an open window area of over 0.5 sq. ft. per capita, not a single high carbon dioxide value was recorded and only six values were obtained with an open window area equal to 0.25 sq. ft.

Table 2 shows the carbon dioxide values obtained, classified according to the condition of the respective workrooms in regard to both exhaust ventilation and extent of window openings. The table indicates clearly that with an adequate exhaust and open windows conditions are always excellent, that with either adequate exhaust or open windows intermediate conditions are obtained while results are generally bad when neither natural nor artificial ventilation is available.

SPECIAL PROBLEMS OF LUNCH ROOMS AND AUDITORIA.

On the two upper floors are two large lunch rooms and several small lunch-

TABLE II.—RELATION OF ARTIFICIAL AND NATURAL VENTILATION TO AIR CONDITIONS.

Carbon Dioxide, parts per 10,000....	4	5	6	7	8	9	10	11	12	13	14	15	16
Rooms with exhaust over 30 cu. ft., window openings over .25 sq. ft. p. c.	5	9	8	6	2								
Rooms with exhaust over 30 cut. ft., window openings under .25 sq. ft. p. c.		1	1	2	1	1							
Rooms with exhaust under 30 cu. ft., window openings over .25 sq. ft. p. c.			12	14	11	2	2		1	1			
Rooms with exhaust under 30 cu. ft., window openings under .25 sq. ft. p. c.	1	1	3	6	6	4	13	11	5	6	2		1

rooms for the clerical force, and a large auditorium.

The register areas serving the lunchrooms were found to be so inadequate as to be practically negligible and the flow of air through them was slight or even reversed in some cases. Of twenty-three temperature records during lunch hours, four were between 72° and 73 degrees, seven between 74° and 75°, six between 76° and 77°, and six between 78° and 79°. Of twenty-three carbon dioxide observations one was 8 parts, eight 10 parts, two 11 parts, three 13 parts, two 14 parts, three 15 parts, and one 20 parts. In the auditorium conditions were even worse.

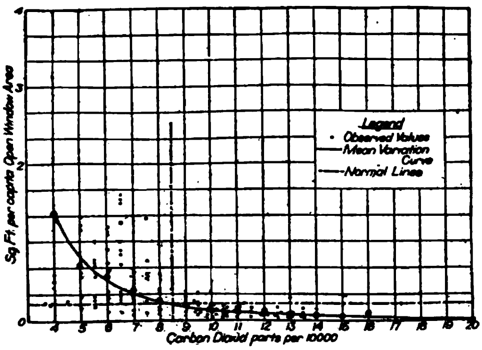


FIG. 6.—RELATION BETWEEN CARBON DIOXIDE AND AREAS OF OPEN WINDOW SPACES IN WORKROOMS.

This room has a fan and supply and exhaust ducts adequate to all demands, but the motor is too small to operate the fan at full speed and the register openings for both incoming and outgoing air are located far above the heads of the occupants. the air enters at the ceiling about 21 ft. above the floor and leaves about 16 ft. above the floor, so that the occupants are not materially benefited. Observations made on five different occasions when the room was in use gave temperature averages of 68°, 75°, 87°, 87° and 87°, and carbon dioxide values of 12, 10, 8, 20 and 13 parts, respectively.

GENERAL CONCLUSIONS AS TO VENTILATION.

According to the standard of 200 sq. ft. of floor area per capita, which we consider a reasonable one, 90% of the workrooms in this building are so crowded as to be in need of artificial ventilation. Out of 118 workrooms studied 41 or 35% had no artificial ventilation at all. Of those which were provided with exhaust ventilation, the per capita air movement was inadequate in 61% of the cases studied. Adding to the 35% of the rooms which have no artificial ventilation, 61% of the other 65%, or 39% of the total, we find that 74% of all workrooms are either not ventilated or ventilated insufficiently. Carbon dioxide determinations confirm this general conclusion, indicating poor air conditions in 42% of the rooms studied. In certain cases, of course, window ventilation made good the lack of artificial ventilation.

Only by either (a) artificial ventilation exhausting at least 30 cu. ft. per minute per capita or (b) an area of open windows equal to at least 0.25 sq. ft. per capita could reasonably low carbon dioxide values be obtained. The usefulness of window ventilation is greatly limited by local and climatic conditions. In warm weather there is no force to drive air in through the windows; in cold weather drafts are objectionable and windows are closed; and at all times the noise and dust of the city streets constitute serious objections. The inadequate artificial ventilation of the building is made obvious to the senses in many of the workrooms by the stale, stuffy odor characteristic of foul air.

In general, then, our investigation showed that both the heating and the ventilating systems had been allowed to fall into such disrepair and to become so ill adjusted to present needs as to fall far short of realizing the purposes for which they were designed. It is just such conditions as these which constantly bring discredit upon the art of heating and ventilation, conditions which can only be brought to light by a comprehensive engineering and sanitary study of actual operation.

District Heating

By S. Morgan Bushnell and Fred B. Orr.

II.—Metering.

(This series of articles commenced in the January, 1915, issue.)

No other factor is contributing more to the present progressive state of the heating industry, or promising more for its continued prosperity, than that of metering the heat supply. Those early pioneers who first launched this industry evidently possessed sufficient foresight to perceive the essential dependence of its ultimate growth and extension upon some such basis as metering.

Accordingly, we learn that the first inventions of steam measuring devices were contemporaneous with or immediately antecedent to the first systems of heat distribution installed. Indeed, the first available records point to the fact that the father of the steam meter was Birdsill Holly, who, as noted in last month's article, worked out a system which still remains, with various modifications, the basis of the industry as we find it to-day.

Appreciating the fact that it would be more equitable to both company and consumer if the quantity of service could be measured, he made application November 29, 1880, for a patent on meters, which was granted May 10, 1881. While it is barely possible, as so frequently happens, that some other inventor was at work simultaneously upon a similar device, no record of such appears, and to Mr. Holly is due the credit for consummating his idea by the actual construction of this meter. It is interesting to note here that in all probability this invention antedates by a few years the first Edison electric chemical meter, which was used quite extensively in the early days of incandescent lighting. This furnishes another instance pointing to the priority of the introduction of central heating over its closely allied industry, central electrical systems.

Briefly, the essential features covered in the Holly patent are as follows:

"This invention relates to improvements in meters for steam or other fluids, in which a paddlewheel is rotated by the impact of steam or other fluid, and the number of its rotations counted and recorded by a counting and recording mechanism similar to the mechanism in gas meters, the steam or other fluid being guided to the paddle-wheel by a self-adjusting guide and the movement or rotation of the paddle-wheel regulated or controlled by the application of a hydraulic brake, as hereinafter described."

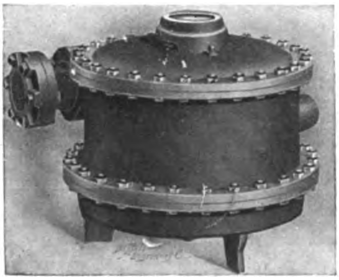


FIG. 1.—THE HOLLY METER.

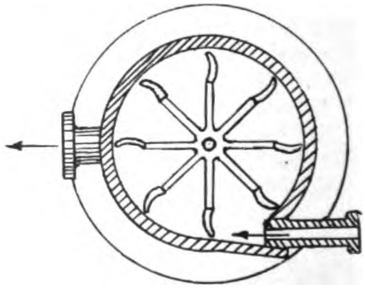


FIG. 2.—CONSTRUCTION OF THE HOLLY METER.

After the appearance of the Holly meter (Figs. 1 and 2) a large number of which were manufactured and used with varying success by a few companies, it seems that no great amount of attention was devoted to the improvement of such devices for a period of more than a decade. During this interval the industry encountered a lull in activity as far as metering is concerned, those stations

which were then installed being forced through lack of a really dependable meter to adopt various methods of flat rate charging.

DEVELOPMENT OF CONDENSATION METER.

With the appearance of the condensation meter, in 1904, a renewed impetus was imparted to the scientific development of commercial heating. It is probably on account of inability to obtain a satisfactory steam meter at this period that heating companies were led to adopt the natural substitute—measurement of condensation, which system now enjoys a greater measure of popularity than ever before, notwithstanding the substantial progress which has been made in the design of flow meters.

Many efforts to design steam meters have ended in failure because frequently it was not recognized that meter design depends upon a very exact knowledge of the natural laws governing the flow of fluids; and even to-day inventors sometimes attempt to construct meters that ignore certain of these facts. Many of the faults which appeared in the first designs have been slowly eliminated by a process of experimentation until there are now on the market a few steam meters which may be considered dependable for commercial use.

THREE METHODS OF MEASURING A CENTRAL STATION'S OUTPUT.

There are three methods of measuring the output of a central steam station, and these are:

1. Water meters, which register the amount of water fed into the boilers.
2. Steam meters, which register the amount of steam delivered from the boilers.
3. Condensation meters, which register the amount of return water of condensation from the various customers.

Water meters are desirable for ascertaining records of station output, and for determining various factors, such as evaporation, efficiency, rate of steaming, etc., and, therefore, some form of them should be found in every first-class steam generating plant, if not equipped with steam meters. Without their agency the efficiency of the boilers is a matter of guess work, and slipshod methods may be expected to prevail not only in the boiler room, but in other departments, if no interest is taken in maintaining a complete plant record at all times. The meters themselves should be frequently checked for accuracy by accurately weighing the water fed to the boilers. When curve drawing instruments are used they indicate not only the total amount of evaporation but also whether or not the water is fed into the boilers in a steady and economical manner.

DIFFICULTIES IN METERING STEAM.

In view of the apparent success of other forms of meters, gas, water and electricity, it would be expected that man's ingenuity could as easily overcome all obstacles to invention in the field of steam engineering. We find, however, that the quantitative determination of steam flow involves a surprisingly large number of variables, affecting the practical limits of design and accuracy.

Could steam be depended upon to obey the theoretical laws of thermodynamics under all ordinary conditions the solution would be evident; but, unfortunately steam cannot be considered a perfect gas, amenable to such formulas. Only when its temperature is maintained well above the point where any moisture can be present (that is to say superheated) will theory coincide with practice. This is seldom the case for any appreciable length of time, and in commercial work the substance is known to be extremely unstable and elastic in form, its properties subject to continuous alteration.

The various conditions affecting the measurements are: density, pressure, temperature, moisture, and superheat, and while it has been the constant endeavor of inventors to compensate automatically for as many of these variables as possible, yet to-day, there is no steam meter on the market which is automatic, in the strict sense applicable to gas, water and electric meters. By this is meant that all steam meters require the addition of more or less computation for securing exact and therefore dependable results. In a classification of steam meters there are primarily two main types, (*a*) area meters which include only the floating-valve type of meters, and, (*b*) velocity meters which comprise all other meters.

Velocity meters are again divided into shunt types and series type.

THE FUNDAMENTAL LAWS OF DESIGN.

Any attempt to present a discussion of meters would be incomplete without some reference to the mechanical laws of design, or the theoretical phases of the problem. Therefore several formulæ must be given in order to gain an accurate knowledge of the fundamentals. An effort will be made to avoid a severe mathematical treatment of the subject and as will be seen only elementary equations, which will be easily understood, will be employed. As the designation implies, area meters are devices designed to determine the flow of fluids by means of a varying cross-section or orifice. The fundamental equation for the flow of any fluid is as follows:

$$W = A \times d \times V \times K \ldots\ldots\ldots (1)$$

in which

W = weight in pounds per second.
A = Area of orifice in square feet.
d = Unit density or weight of the fluid in pounds per cubic foot.
V = Velocity in feet per second.
K = Co-efficient determined by experiment.

Upon this formula is based the design of all types of water and steam meters, including both area and velocity types.

When certain known values are assigned to the various factors, in equation (1) a solution is possible. Suppose, for simplicity of explanation, that the values d and K be considered unity in all cases. We thus have:

$$W = A \times V \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

To solve this equation some one of the variables must be constant and another determinable for a certain condition. If, for example, the velocity "V" is assumed to have a constant or fixed value, it will be seen that the value of "W" varies as the area "A" or, conversely, for different quantities of flow the area must increase or decrease if the velocity is to remain the same under all conditions of flow.

Now before progressing further, let us consider a very vital fact, namely, that the flow of a fluid, steam for example, through a pipe or orifice is produced by a drop or lowering in pressure between the inlet and the outlet or discharge. Just as hydraulics teaches that water seeks its level, so equilibrium is established through increased velocity in a pipe line discharging steam.

The drop, therefore, is a function of the velocity; and with a certain definite drop through an orifice of constant cross-section the amount of steam passing through the orifice will vary with the size of the orifice. The recognition of these two relations led to the invention of a type of steam meter which we have just classified as "area meters," but which are also known by various other names, such as: displacement meters, cross-section meters, throttling meters, and valve meters.

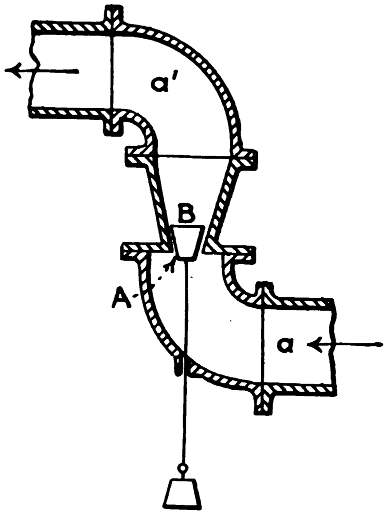


FIG. 3.—DIAGRAM SHOWING BASIS OF DESIGN OF AREA METERS.

The above simple mathematical considerations upon which are based the design of area meters, will be better understood by referring to Fig. 3. This diagram comprises three elements: "A", the restricted orifice, in a pipe line; "B," the movable valve disc; and "C" the balance weight.

Suppose the system to be at rest, *i. e.* no steam flowing. The valve disc "B" would be kept seated tightly by a weight "C." Now, if steam be admitted to "A" its pressure distributed over the lower surface of the valve—will tend to overcome the weight "C" permitting same to rise from the seat. This allows steam to flow through the orifice and enter the chamber (a). Of course, the pressure of the steam will immediately operate here on the upper surface of the valve

and have a tendency to counteract the upward rise of B. The area of these surfaces being equal, it will be understood that the additional force C, downward, will necessitate a greater pressure per square inch at "a" than at "a," if equilibrium is to be established.

According to the Bernouilli theorem, the sum of the pressure head, velocity head and friction head (or loss) must be constant in any two portions of a pipe containing a flowing fluid. If these factors are represented by P, $\frac{V^2}{2g}$ and F, respectively, then

$$P_1 + \frac{V^2}{2g} + F_1 = P_2 + \frac{V_2^2}{2g} + F_2 = K$$

The friction loss through short orifices or pipes may be neglected and therefore we have the purely theoretical assumption:

$$P \text{ (Potential Energy)} + \frac{V^2}{2g} \text{ (Kinetic Energy)} = K$$

from which it follows that the various energies in the fluid per unit of mass, are interchangeable and susceptible of transformation or conversion into other forms, their total remaining a constant.

This is exactly what occurs in the example we are considering. The potential energy (or pressure head) in flowing through the orifice "P_2 a_2" is reduced below the value "P_1 a_1," by a certain definite amount depending upon the design of the different component parts, including the weight C. This drop in pressure (P_1 a_1—P_2 a_2) is transformed into kinetic energy (or velocity head) and the result is an increase in velocity through the restricted area due to the throttling effect of the valve. Conversely, this throttling energy or pressure drop is utilized in lifting the valve from its seat. The valve is so tapered that the vertical movement of B is directly proportional to the increase in net area and, therefore, to the weight of steam flowing. This movement, when recorded by suitable devices, gives a continuous record of all momentary variations of flow. The theories stated above enable us to deduce a workable formula for area or throttling meters.

For the factor V, Equation (1), we may substitute its equivalent as represented by the well-known form:

$$V = \sqrt{2gh} \quad \ldots\ldots\ldots\ldots (3)$$

Where V = Velocity in feet per second.
g = Acceleration of gravity = 32.2 ft. per second.
h = Head in feet, of an imaginary column of the fluid, corresponding to the increase in velocity head or which would be supported by its equivalent, the pressure drop.

The value "h" is determined, as we have just seen, by the pressure drop through the orifice, and may be computed as follows:

The pressure per square inch exerted by a column of fluid having a density "d" pounds per cubic foot is equal to (d ÷ 144), therefore, we have:

$$h = (p_1 - p_2) \div \frac{d}{144}$$

where

P_1 = Initial pressure — below the valve — pounds per square inch absolute.
p_2 = Discharge pressure — above the valve — pounds per square inch absolute.

Therefore equation (3) becomes,

$$V = \sqrt{2g \frac{(p_1 - p_2)}{\frac{d}{144}}} =$$

$$\sqrt{2g \frac{(p_1 - p_2)\ 144}{d}} \quad \ldots\ldots\ldots (4)$$

Substituting in (1)

$$W = A \times d \times K \times \sqrt{2g \frac{(p_1 - p_2)\ 144}{d}}$$

Clearing this equation we have:—

$$W = A \times K \sqrt{d\,(p_1 - p_2)}.$$

and since (p_1 - p_2) is a constant for any one meter, depending only on the arbitrary weight of the valve the equation may be further simplified by incorporating this value in the constant K. Accordingly,

$$W = A \times K \sqrt{d} \quad \ldots\ldots\ldots\ldots (5)$$

This formula represents the theoretical action of area meters and has been found

to be in remarkable agreement with actual test results throughout practically the entire range of pressures for which the meter is designed. Thus, if we know the characteristics of each meter as it leaves the manufacturer:—viz., the drop in pressure ($p_1 - p_2$) and the net area of the orifice for certain rises of the valve, the performance of the meter may be very closely approximated, by calculation. However, there is no necessity of this in practice, since each meter is calibrated before leaving the factory, by passing steam through it and thence into a surface condenser, enabling measurement of the condensed steam to be made on suitable platform scales.

FIG. 4.—ST. JOHN METER.

An empirical formula extensively employed by engineers for computing the flow of steam, through an orifice is given in Babcock & Wilcox "Steam."

$$W = A \times K \sqrt{p_2 (p_1 - p_2)}$$

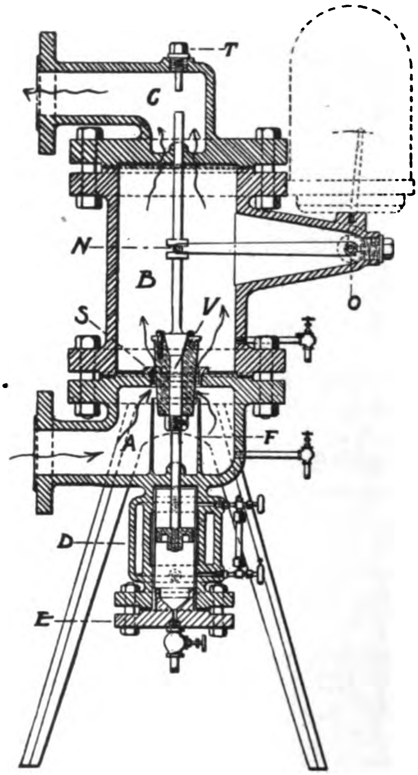
in which the notations are as given in equations (4) and (5). This formula may be reduced to the form

$$W = 1.7 \times A \sqrt{p_2 (p_1 - p_2)} \ldots . (6)$$

and will be found to check favorably with formula (5).

TYPES OF STEAM METERS.

Fig. 4 illustrates the St. John meter, first patented about 1893. This is representative of the area type of meter and has enjoyed perhaps more popularity among steam companies in this country than any other meter of this type.



INTERIOR CONSTRUCTION OF ST. JOHN METER.

Most engineers are familiar with the action of the pressure reducing valve in which the steam flowing in a pipe line is throttled or wire drawn through an opening or orifice which is smaller than the size of the inlet pipe. The steam after passing through this restricted orifice expands to a lower pressure on the outlet side of the valve. This throttling action is controlled by means of a diaphragm with adjustable tension spring or weighted lever arm so as to maintain any desired throttling effect on the valve and

reduce the discharge pressure to any extent, regardless of the initial pressure. This produces the "drop in pressure" referred to above. Equation (3).

Generally speaking, the action of the St. John meter and other meters of this type may be compared with that of the reducing valve just described. The meter is so constructed that the function of the springs and diaphragm is taken care of by the tapered valve or plug which is mounted on a vertical guide shaft, free to move in a vertical direction in proper openings; and so proportioned and of such weight that, with a constant throttling effect or pressure drop of about 2 lbs. per square inch through the valve seat (which in this case is called the orifice) the valve or plug will be caused to float freely in the path of the flowing steam, its height from the valve seat being proportional to the quantity of steam flowing at any instant. Fig. 5 shows the detailed construction of this meter.

In operation, the meter is inserted at a convenient point in the steam line and the steam enters the lower inlet connection, A, and leaves at the top of the outlet connection, C, which is connected again into the main steam line. When no steam is flowing, the tapered valve or plug, V, will seat itself due to its own weight and remain tightly set against the valve seat, S. While in this position, the yoke, N, and the lever arm, O, will be in their lowest positions; consequently the pencil arm and the dial reading will record zero. When steam is admitted at A, the valve V will tend to rise after the pressure has built up sufficiently to overcome the weight of same.

Because of the tapered form of this valve, as shown in Fig. 5, it is seen that the vertical movement of same will increase the orifice area from zero to the maximum when the valve spindle is raised to the valve stop, T. The rate of increase of area depends solely upon the amount of taper given the valve and it is upon these factors that the quantity of steam is determined.

The weight of the valve (V) together with all its attachments, must be such that it may be exactly balanced and able to float and preserve its equilibrium in the path of the steam when there is exerted a differential pressure of about 2 lbs. per square inch between the inlet and outlet chambers. Thus is established the principle set forth above that if this difference of pressure is at all times maintained, regardless of any position the valve may assume, the quantity of steam will vary as the net area of the orifice. Furthermore, it is evident that the orifice area is proportional to the rise of the valve; consequently this rise is a direct indication of the quantity of steam flowing at any instant. This vertical rise when transferred by means of the lever and pencil arm will trace a line on a paper chart giving a continuous record of the flow of steam during any desired period not to exceed two weeks' duration.

THEORY OF VELOCITY STEAM METERS.

Referring again to the fundamental equation,

$$W = A \times d \times V \times K \ldots\ldots\ldots\ldots (1)$$

We find that a different solution is possible than that arrived at as the basis of area meters; namely, that we may assume a certain orifice or area of constant cross-sectional area "A," and allow the changeable steam flow to be measured in terms of the resultant variation in velocity. This law forms the basis of the so-called velocity meters. The basic principle of velocity meters is, in the last analysis, not essentially at variance with the area meter, since there is involved in either the element of pressure differential. This type, however, embodies the application of the well-known idea of the pressure equivalent of velocity which is familiar to engineers generally, as exemplified by the Pitot tube, Venturi tube, throttling disc and modifications thereof. However, a great many years of experimentation were required before any headway was made in the art of metering steam by variable or natural velocities.

Next month the authors will discuss the theory of velocity steam meters and will show representative types of these devices. Condensation meters will also be considered.

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WHILE the determination of what is and what is not good air for breathing purposes has made some headway during the past year, it still remains a fact that so far the results indicated by the investigations are comparatively negligible. For instance, in the experiments conducted by the New York State Commission on Ventilation, the tests were those that were calculated to determine the correctness of modern ventilation theories. There were mental efficiency tests with young men in five varying atmospheric environments ranging from comparatively cool to hot temperatures and with different air supplies, from practically nothing up to 45 cu. ft. per minute per person. The relative humidity was also varied from 50% to 80%. These tests were accompanied by a measurement of the physiological responses and the opinions of the subjects as to their state of comfort was also recorded. The experiment was planned to give information on the subjects' efficiency in a hot, moist room as compared with a cool room; in a room with ample supply of fresh outdoor air as compared with a room in which no air at all was supplied; and a hot, moist room where relief was afforded by the moving air from electric fans.

It is sufficient to say that the only appreciable result on this particular group of subjects was a partial loss of appetite on hot days and on either hot or cool days when the air supply was low. There was, to be sure, a response in the temperature of the body to the temperature changes in the surrounding air, but this was slight (less than 1° C.). There was also less inclination to do work with the higher temperatures, but this statement relates to the amount of work done voluntarily rather than the amount which might be done under necessity.

The commission frankly states that it is difficult at this time to arrive at any sweeping conclusions as to the relative importance of different ventilation factors. It should be noted, however, that a detailed study of the effects of humidity have not been studied at all to date. These will be taken up, however, in the experiments to be made during the coming year in one of New York City's public school buildings, where two classrooms have been equipped so that any desired variation of air movement and humidity may be secured.

Regarding stagnant air, lacking a definite disagreeable odor, but containing all the products of the exhaled breath, including carbon dioxide in excess of 30 parts per 10,000, so far it has only been found to be objectionable "in a manner as yet unknown, but demonstrated by a lessened desire for food," and otherwise showing no debilitating effect on the mental processes or on the various physiological reactions which have been studied in these experiments.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Twenty-First Annual Meeting, January 20-22, 1915

With a number and variety of papers that surpassed those presented at any previous gathering, the twenty-first annual meeting of The American Society of Heating and Ventilating Engineers, held January 20-22, 1915, at the Engineering Societies Building, New York, will take rank as one of the most interesting and probably the best-attended in its history.

Without doubt, the most important single achievement at the meeting was the formulation of a set of definite requirements for a compulsory ventilation law. This was put forth in place of a model law, which it was found impossible to draft to meet all conditions.

The suggested requirements, therefore, were made up instead, separate sets of requirements being included to cover different classes of buildings. As soon as these requirements have received the finishing touches of the council of the society, they will be placed in the hands of all the boards of health in the country as well as being given general publicity.

Emphasis was laid on the fact that they are not intended to be the last word on the subject, but are something definite that can be used until further progress in the art brings to light any changes or additions that are necessary.

DWIGHT D. KIMBALL,
President, American Society of Heating and Ventilating Engineers.

Afternoon Session, January 20.

President Samuel R. Lewis opened the meeting by presenting his annual address, which was a discussion of operating costs.

This was followed by the report of the Secretary, J. J. Blackmore, who made the announcement that Volumes 19 and 20, covering the years 1913 and 1914, have now been issued, thus bringing the transactions of the society up to date. He showed the affairs of the society to be in excellent shape, with sufficient funds on hand to meet all obligations and leave a comfortable balance on hand. The excess of the society's assets over its liabilities was reported to be $9,087.42, giving an average equity per member of $17.92.

The report of Treasurer James A. Donnelly gave details of the receipts and expenditures for the year, the total receipts being $6,362.49, which, added to last year's balance, made a total of $8,-932.40. The disbursements for the year were $6,587.66, making the balance $2,344.38.

The council, in its report, spoke of the resignation of Secretary E. A. Scott and the appointment of J. J. Blackmore to be constantly employed in the secretary's office. The council stated that the membership has grown during the year to a

greater extent than ever before and the income has materially increased.

The council expressed its opinion that the prosperity of the society and its influence for good will be greatly enhanced if a permanent secretary can be retained. The council also expressed its belief that the secretary of the society should be conversant with every branch of engineering that relates to heating and ventilation, for often the secretary has to represent the society before engineering schools and societies to secure co-operation in the work of the society.

It was shown that 80 members had been added to the roll during the year, the net increase, after deducting losses, being 45, making the present membership 507.

A number of suggested amendments were presented in the report of the council, which were taken up at a later session.

REPORT OF COMMITTEE ON VENTILATION STANDARDS.

One of the most important matters to be taken up by the meeting was presented at this session, consisting of a 27-page report of the committee appointed January, 1914, to prepare a set of minimum ventilation requirements for public and semi-public buildings which the society can recommend for legislation.

The committee's recommendations, as presented by Frank T. Chapman, were based on volume and CO_2 content and embraced sections on "General Suggestions for the Compilation of Laws for Compulsory Ventilation," "Schools and Colleges," "Factories" and "Theaters." These were supplemented by an appendix containing details for fulfilling the requirements which are those used by the Ventilating Division of the Chicago Department of Health.

A lengthy discussion arose over this report, M. W. Franklin making the point that since the physiologists and sanitarians had shown the unimportance of carbon dioxide as an air test, and that the principal causes of so-called bad ventilation were due to excessive heat and humidity, the requirements for ventilation should be based upon regulating the heat and humidity, rather than on supplying definite air volumes.

He said that the air quantities contained in the report were, under the circumstances, purely arbitrary and might or might not be necessary.

Mr. Franklin also deprecated the provision allowing local Boards of Health to vary the requirements.

Other speakers referred to the lack of provision for the cooling of theaters. This, it was pointed out, is often more necessary than their heating or ventilation.

The report was finally disposed of by giving it the approval of the society subject to such modifications as are necessary, these to be made by the new council.

It is hoped that the report will be in final shape for publication by March of this year. When ready it will be sent to every Board of Health throughout the country. The point was emphasized that the report is not intended to be a model compulsory ventilation law, as the committee had found it impractical to attempt to draft a model law with the necessary legal phraseology. The report, therefore, is devoted to general suggestions for minimum heating and ventilation requirements that are applicable to the classes of buildings as given. The full committee was composed of J. D. Hoffman, chairman; E. Vernon Hill and Frank T. Chapman.

The next report was that of the committee on the development of heating and ventilating industrial buildings, E. L. Hogan, chairman. This report recommended that the society take up the matter of standards of heating or methods of determining heat losses. The report was received and referred to the council, with the recommendation that the matter of such standards be taken up by the committee on standards.

A report was then presented by the committee on the best place to locate radiators in rooms, W. F. Verner, chairman. This report was read by Secretary Blackmore and stated that it was hoped to submit in the near future results of tests made by placing radiators in different parts of rooms which will be of different size and shape and with the walls exposed in various ways.

The committee on chimneys and their effect on heating and ventilating apparatus was not yet ready to report.

ANNUAL DINNER OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS AT THE HOTEL McALPIN, NEW YORK, JANUARY 21, 1915.

President Lewis then appointed as tellers of election, F. K. Chew, W. G. R. Braemer and F. K. Davis.

The election of a nominating committee was then taken up and resulted in the election of the following: Frank K. Chew, chairman; Bert C. Davis, William G. Snow, Hugh J. Barron and J. I. Lyle.

WILLIAM J. BALDWIN ELECTED AN HONORARY MEMBER.

While the tellers were counting the ballots President Lewis announced that William J. Baldwin, whom he described as the "dean" of the heating profession, had been passed by the council for honorary membership. On putting the matter to the meeting Mr. Baldwin was elected unanimously.

Mr. Baldwin, who was present, responded gracefully to the society's action and expressed his appreciation of the honor which, he said, he would be very happy to make use of.

CHARTER FOR ST. LOUIS CHAPTER.

President Lewis then announced that the St. Louis members had made application for a charter for a local chapter at that point. Their application, he said, had been passed by the council, and was now up to the meeting. On being put to a vote the application for the charter was granted by unanimous vote.

Under new business, the proposed amendments to the constitution were taken up. The principal amendment proposed was one widening the scope of membership to include "chemists, physicians, health or ventilation inspectors, and scientists." This aroused a lengthy discussion and was eventually voted down.

Evening Session, January 20.

At the opening of the evening session the report of the tellers was presented, showing the election of the following:

NEW OFFICERS.

President—Dwight D. Kimball, New York.

First Vice-President—Harry N. Hart, Chicago.

Second Vice-President—Frank T. Chapman, New York.

Treasurer—Homer Addams, New York.

Council—D. D. Kimball, Harry N. Hart, Frank T. Chapman, Homer Addams, Frank Irving Cooper, Boston; E. V. Hill, Chicago; W. M. Kingsbury, Cleveland, O.; Samuel R. Lewis, Chicago; Frank G. McCann, New York; J. T. J. Mellon, Philadelphia; Henry C. Meyer, Jr., New York, and Arthur K. Ohmes, New York.

The first paper of the evening session was one by A. M. Feldman, on "An Experiment with Ozone as an Adjunct to Artificial Ventilation at the Mt. Sinai Hospital, New York City." This paper reported gratifying results secured in this instance through the use of ozone, the writer stating that its use neutralized certain odors generated in the room in which it was installed, as attested to by the nurse in charge and by the attending and visiting physicians. The results reported by Mr. Feldman were corroborated by M. W. Franklin, who gave details of the experiments conducted by him in which it was demonstrated that ozone definitely destroyed such odors as those emanating from limburger cheese, etc.

The next paper had a special significance to the society in that it was written by the late Frank L. Busey and completed a short time before his death. The paper was based upon a lecture delivered by Mr. Busey before the New York and Illinois Chapters of the Heating Engineers' Society, and was entitled, "The Centrifugal Fan, the Development, Performance and Selection of the Steel Plate and Multivane Types." The paper was read by Willis H. Carrier, a fact which also had a special significance because Mr. Carrier and Mr. Busey were closely associated in much of their experimental work. As its title indicates, the paper showed all of the important types of fans, covering practically the entire history of the art. A section was devoted to a discussion of the relation between static velocity and total pressure, and between static and total efficiency of centrifugal fans Another portion took up the relative performance of the straight and curved blades and of the steel plate and multivane types of fans. The paper concluded with some practical suggestions on fan selection.

At the conclusion of the reading of the paper a rising vote of thanks was tendered to Mrs. Frank L. Busey for her kindness in sending the paper to the society.

The next paper was one on "Engine

Condensation," by Perry West, with particular reference to heating with the exhaust.

A written discussion of Mr. West's paper was presented by David Moffatt Myers, in which he took issue with Mr. West's figures for heat losses in passing high pressure steam from a boiler through a system of piping and thence through a reciprocating engine. These losses were given by Mr. West as between 15% and 20%, while, according to Mr. Myers the losses would not run over 13% as a maximum. In his reply, Mr. West stated that his figures referred especially to small engines, while those of Mr. Myers referred to very large engines.

Owing to the fact that a paper was on the programme which had a direct bearing on the discussion, it was then presented. This paper was entitled "The Heating Value of Exhaust Steam" and was read by the author, David Moffatt Myers, containing a chart by which it can easily be ascertained, with any type of engine, what the per cent of B. T. U. of initial steam is contained in the exhaust mixture in the form of dry saturated steam.

As a result of the discussion, which finally turned on the comparative heating value of live and exhaust steam, President Lewis appointed a committee consisting of William Kent, Willis H. Carrier and David Moffatt Myers to look into the matter and report to the summer meeting of the society. This committee will look especially into some results reported by Mr. Ripley which showed a percentage of 14% in favor of exhaust steam, in connection with a particular installation he had had under observation.

Morning Session, January 21.

The Thursday morning session was opened with a voluminous report by D. D. Kimball and George T. Palmer, of the New York State Commission on Ventilation, giving the results of physiological and psychological observations during the first year's experiments. While no especially important results have been obtained so far, the series of appetite experiments were considered, the most noteworthy in that the appetites of subjects decreased with an increase in temperature. In these tests the two temperatures used were 68° F. and 86° F. The tests were fairly consistent in showing a better appetite at the lower temperature.

In commenting on the report, Prof. C.-E. A. Winslow, the chairman of the commission, took occasion to disavow the newspaper reports, which credited him with the opinion that stagnant air, if in a cool condition, was suitable for breathing, and practically as good as fresh air.

Prof. Winslow said that even if no ill effects could be traceable directly to stagnant air, the fact remains that such air is objectionable on grounds of decency alone, just as the lack of bathing is not to be tolerated.

J. H. Davis, of Chicago, expressed his pleasure at hearing Prof. Winslow's disclaimer of the stand attributed to him, as he said the alleged statements had been widely circulated and had had the effect in Chicago of making it appear that the attitudes of the New York and Chicago ventilation commissions were at variance, whereas Prof. Winslow now showed that this was not the case.

President Lewis also spoke of the erroneous reports regarding Prof. Winslow's opinions and urged that as wide publicity as possible be given to his actual remarks.

In the course of the discussion Mr. Kimball extended an invitation to the members to visit the laboratories of the New York Ventilation Commission. A motion was passed designating the following day for the trip and arrangements were made for the members to make the trip in a body, going both to the City College and to Public School No. 51, where two specially-constructed rooms will be used for experimental purposes.

Reginald Pelham Bolton then read a paper on the "Problem of City Dust," in which he reviewed the analysis of A. A. Cary of the composition of solid materials emitted with furnace gases or smoke, showing the very considerable quantities of such materials emitted. He also showed that bacteria are vastly more numerous in the air of cities than in the atmosphere of the open country, and quoted the results secured by Dr. George A. Soper in his tests of air in the New York Subway, showing the excessive quantities of bacteria in the subway air. His conclusion emphasized the need of cleaning the air in ventilating systems, as well

as the inadequacy of open window and so-called fresh air methods of ventilation.

The next two papers were on the same general topic and were presented together. There were on "Cinder Removal from the Flue Gases of Power Plants," presented by the author, C. B. Grady, and on "Studies in Air Cleanliness, by Profs. G. C. and M. C. Whipple, read by Secretary Blackmore.

Mr. Grady's paper showed the methods used at the Waterside Station No. 2 of the New York Edison Company for disposing of the cinders which were a cause of annoyance to those in the neighborhood. Results of tests were included, giving the extent of cinder removal amounting to 95% and other interesting points in connection with the movement of the stack gases.

Messrs. Whipple's paper was devoted largely to a series of experiments made in Cambridge, Mass., during the past year for the purpose of determining the distribution of atmospheric dust in different parts of the city. It was shown that the industrial communities of a city contain a greater amount of precipitated impurities than in better cared for districts. It was also shown that the nature and volume of the traffic on streets influences the cleanliness of the air above them.

The samples were taken at a level of 25 ft. above the street and, from comments made in the ensuing discussion, the paper was considered chiefly valuable as giving a method for making such studies.

Mr. Bolton, who discussed the paper, called attention to the fact that in both the old and new subways in New York, arrangements are made to take in the air supply through gratings in the sidewalk. This he characterized as reprehensible to a degree and said it was high time that the matter of admitting quantities of harmful dust through the use of such air intakes was given more serious consideration and steps taken to prevent such practices.

In discussing the dry removal of dust and cinders, William J. Baldwin described an apparatus he had designed which he had found effective.

F. K. Davis called attention to the growing presence in the atmosphere of what he termed an oily dust due to the spreading of oil as a dust preventative. He said on that account that the society should be careful not to go on record as stating that oil will effectively lay the dust. Harry N. Hart also called attention to the amounts of rubber dust found in air samples in Chicago, evidently given off by automobile tires.

Afternoon Session, January 21.

The first paper Thursday afternoon was presented by Prof. C.-E. A. Winslow on "A Study of Heating and Ventilating Conditions in a Large Office Building." This building has modern heating equipment with a system of temperature control. The results, however, showed it to be overheated most of the time. It was also shown that the air change was inadequate. In general, the investigation disclosed that both the heating and the ventilating systems had been allowed to fall into such disrepair and to become so ill-adjusted to present needs as to fall far short of realizing the purposes for which they were designed.

The discussion which ensued brought out the fact that in many cases the desire of the operating engineers to make a good showing in fuel economy was responsible for the failure to properly operate heating and ventilating systems.

One remedy for this, proposed by President Lewis, was to make the heating of the building, where a fan is installed, dependent upon the operation of the fan.

It was also brought out that the operating engineers are making noteworthy efforts to improve their knowledge, as evidenced by the discussions which take place at the meeting of their various unions. F. K. Davis proposed that they be invited to attend the chapter meetings of the society, in that way bringing the designing and operating engineers into closer touch with each other.

The next paper was by Frederic Bass and was entitled "The Recirculating of Air in a Schoolroom in Minneapolis." In this paper Mr. Bass supplemented the results reported in a previous paper with further tests along the same lines. These experiments consisted principally in supplying air to the pupils through individual air orifices at each desk top. Air was exhausted at the ceiling through fifteen 3-in. orifices, evenly spaced, and recirculated after passing through a Webster air washer which had the effect of cooling the air about 15° F.

The tests did not show any physical or mental deterioration resulting from the use of recirculated air. There were, however, slight odors to be noticed by one entering the room, but these, he said, were not offensive to persons occupying the room continuously, although the air supply was as low as 8.9 cu. ft. per pupil per minute.

The significance of the results were emphasized by the comparison made by Mr. Bass with the results obtained in another school building containing the usual system of plenum fan ventilation.

In the discussion Willis H. Carrier made the point that with the low air supply as given, the figures for the increase in the carbon dioxide content, when the number of pupils was taken into consideration, could not be accepted as correct. It was a physical impossibility, he said, for the carbon dioxide to remain so low without a considerable addition of fresh air, even after allowing for the amount of carbon dioxide taken out by the air washer. This view was also taken by Arthur K. Ohmes in a written discussion of the paper.

This paper was followed by one on "The Ventilation of Sleeping Cars; Comparative Tests of Various Types of Exhaust Ventilators," presented by the author, Thomas R. Crowder, M.D.

Dr. Crowder's paper was along the line of his previous discussion of this subject. (See THE HEATING AND VENTILATING MAGAZINE for May, 1913.) He called attention to the fact that at each breath we take back into the lungs the expired air which is lodged in the nose and larger bronchi—the so-called "dead space" air. This dead space, he said, constitutes about one-third of the volume of a quiet inspiration. He said the normal amount of carbon dioxide in the air actually breathed was about 5%.

Fresh air, he said, must now be looked upon as air that will have the capacity for taking away the excess body heat. This amount, curiously enough, corresponds closely to that long since arrived at as the air supply necessary to maintain the requisite degree of chemical impurity, but on the new basis it must be cooler air or dryer air or air having more motion.

Dr. Crowder then described the system of exhaust ventilation designed by him which makes use of exhaust ventilators applied to the roof of the car. The paper contained numerous charts showing the results of observations in cars of varying types of construction. These included tests made with different types of exhaust ventilators, the results emphasizing the value of exhaust ventilators for cars, and the superiority of the so-called standard ventilator used on the cars of the Pullman Company.

Other speakers called attention to the fact that the principal trouble experienced in sleeping cars was the high temperature and advocated the use of some regulating device or other method to maintain a lower temperature.

F. K. Davis asked if any experiments had been made recently having a bearing on the matter of the toxic poisoning of the air, as brought out by Messrs. Rosenau and Amoss. Dr. Crowder replied that subsequent experiments had negatived these results and added that even if there was such a thing as toxic poisoning, the ability of the body to adjust itself to such conditions, as evidenced by the fact that the inhaled air always contains a portion of that expired, showed that the lungs were already constantly being filled with such poison.

He said the diminution of one-half of 1% of carbon dioxide on the blood pressure simply resulted in a slower breathing while the addition of a similar amount increased the rate of breathing 100% until the effects of this pressure were overcome. He added that the faculty of the body to take care of such effects was almost incomprehensible.

The next paper of the session was on the "Ventilation of Industrial Plants," by C. T. Graham-Rogers, M.D., director, and William T. Doyle, mechanical engineer, of the Division of Industrial Hygiene of the New York State Department of Labor. This paper was read by Secretary Blackmore.

The paper told of the work done by the division and emphasized the necessity of carrying on a campaign to show the factory owners the value in dollars and cents, through the increased efficiency of the workers, of providing adequate ventilation.

President Lewis said it was quite noticeable in the Middle West that many of the new factory buildings were being

equipped with what corresponded almost to school house types of heating and ventilation systems.

J. H. Davis said that the experience of the American Radiator Company in installing an adequate ventilating plant in one of its new buildings was so satisfactory that the company has now installed elaborate systems of ventilation in all of its plants.

The final paper of the afternoon session was presented by C. A. Fuller and was a report on a "Test of a Cast-Iron Sectional Down-Draft Boiler." The heater tested was a Peerless boiler. In this test no smoke was visible between the firing periods when burning run of mine bituminous coal. The results showed 8.75 lbs. of water evaporated per pound of dry coal, the boiler having a grate surface of 22 sq. ft. and a water heating surface of 210 sq. ft. One of the points noted in the test was the comparatively high efficiency with a high stack temperature. The efficiency of the boiler was shown to be 67.9%.

It was brought out in the discussion that the firing was done every half hour. It was also noted that the figures for grate area should probably be 11 sq. ft., since the lower grate should really be considered as a hearth.

Another point brought out was that with this type of boiler it was good practice to install a boiler from 75% to 100% above the estimated capacity required. This would give better operating conditions in such ways as less frequent firing.

Afternoon Session, January 22.

At the opening of the Friday afternoon session, a paper by C. G. Dunnell was read on "Tests of Threading Steel and Wrought Iron Pipe." In the absence of Mr. Dunnell, this paper was presented by Frank N. Speller, metallurgist of the National Tube Company. The paper was illustrated by lantern slides giving an idea of the different types of dies in use and the economy of using a die with the proper pitch, etc. The comparisons showed that considerably more force is required to thread hard steel pipe than is required to thread either wrought iron or soft steel. Comparing iron and steel pipe it was found that the force required to thread is somewhat to the advantage of the iron.

As regards the matter of splitting while being threaded or bent it was found that it took at least 25% more force to twist open the seam in the steel pipe than in the wrought iron.

The next paper was on "Some Phases of Room Heating by Means of Gas Burning Appliances," by George S. Barrows. As stated by the author, this paper was supplementary to the discussion which took place at the 1914 summer meeting of the society. Mr. Barrows is a member of the Committee on Utilization of Gas Appliances of the American Gas Institute. His paper was a broad discussion of the subject and included the topics of central heating, that is, a system to supply several rooms, and individual room heating. Under the latter heading the speaker discussed stationary and portable heaters.

Mr. Barrows strongly emphasized the need of flues to carry away the products of combustion, except when of the smallest size or when installed in well-ventilated rooms. Another function of the flue is to assist in the general ventilation of the room.

The paper contained illustrations of common types of heaters, with a description of each type. These included gas-fired steam radiators.

In discussing the paper one speaker spoke of the high rates made by insurance companies where gas heaters were installed as having an important effect on the cost of operating such systems.

Mr. Barrows said that the gas steam radiator had been approved by the National Underwriters' Laboratory in Chicago and is not regarded as a hazardous risk.

In response to an inquiry Mr. Barrows explained the method of determining the efficiency of the gas radiator as far as the emission of radiant heat was concerned.

The question was asked as to why a gas steam radiator should be used. This was explained by several speakers on the ground that a gas steam radiator will be at a lower temperature than a simple gas radiator, also that the greater surface obtainable with a gas steam radiator permits of utilizing a larger amount of what is distinctly radiating surface.

A paper was then presented by James S. Otis on "Capacity of Steam Pipes at

Different Pressures," in which he presented a number of tables covering pipes of different diameters. As stated by Mr. Otis the feature of the tables was the capacities credited to pipes of the smaller diameters, which were lower than those generally used. These figures, he stated, were found by him to conform more closely to actual practice as well as agreeing with the most recent researches of French, Swedish and German authorities.

Prof. William Kent opened the discussion by stating that the capacities given in the tables correspond closely with those obtained by the Wilcox & Babcock formula, so that on that account their value as something new or different on this subject might be questioned. He also showed that the tables and the formula given in the paper did not correspond so that it remained for the author to present any data he might have so that the tables could be properly checked.

In replying Mr. Otis stated that when the loss of heat from the pipes is considered, as mentioned in the paper, the formula as given will be found to agree with the tables.

Roy E. Lynd then presented a paper on "Rational Methods Applied to the Design of Warm Air Heating Systems." The principal feature of this paper were charts giving practically all the data needed by the designer in proportioning warm air pipes to heat any ordinary room, and giving warm air heater capacities under different conditions of efficiency; also the free air area through the heater under different conditions.

In addition Mr. Lynd gave a specific example showing how the charts would be used in heating a typical house. This was figured for the use of outside air supply, also for furnishing ventilation for six persons and, third, for recirculating air entirely.

Prof. Kent in discussing the paper predicted that the ideal warm air furnace heating system of the future will be one that has an outlet as well as an inlet in each room or apartment. This, he said, would probably take care of the uncertainty of the obstruction factor in the formula for the flow of the warm air.

At this point President Lewis expressed his appreciation of the work done by Secretary J. J. Blackmore and called for a rising vote of thanks to Mr. Blackmore which were given unanimously.

President Lewis then resigned the chair to former President William M. Mackay, who had been delegated to inaugurate the newly-elected officers, which was done with the ladies present. Mr. Mackay, in addressing the meeting, referred to the birth of the society twenty-one years ago and traced its growth and development since then. Hugh J. Barron and B. G. Carpenter were appointed a committee to escort the new officers to the rostrum. Each was separately inducted into office with appropriate remarks by the chairman.

The new president, Dwight D. Kimball, on assuming the chair, pledged his interest to the advancement of the society's objects. He then called on the other officers for remarks, which were made by Vice Presidents Hart and Chapman and Treasurer Addams.

At the conclusion of the installation ceremonies, the meeting adjourned.

The Entertainment.

The total registration of 250 at the meeting of the heating engineers' society included no less than 31 ladies, so that the plans made by the entertainment committee were carried out with much enthusiasm and with notable success. This is especially true of the society dinner which was held Thursday evening, January 21, at the Hotel McAlpin.

On the opening day of the meeting the ladies were entertained at tea at the Colonial Tea Rooms and in the evening, previous to the opening of the evening session, a social reunion was held in the lobby of the Engineering Societies' Building.

On Thursday morning the ladies were taken to the Wanamaker store, where special guides conducted them through the various departments. Here luncheon was served and in the afternoon a Swedish concert was given for them in the auditorium of the store.

The society dinner, on the evening of Thursday, was held in the ballroom of the Hotel McAlpin on the 24th floor. The tables were arranged for dancing between courses. This proved a highly popular innovation and dancing was generally indulged in, both during the dinner and afterwards.

There were but two stated speeches, one by the retiring president, Samuel R. Lewis, who acted as toastmaster, and the other by the new president-elect, Dwight D. Kimball. Mr. Kimball spoke at length upon the work of the society and suggested, among other things, that the society might find it advantageous to

publish a bulletin for the information of its members and such a bulletin could contain the papers to be presented at the society's meetings.

Following the formal addresses, there were impromptu calls for remarks during the lulls between the dances and among those drafted into service were Henry G. Issertell, who gave a humorous account of his running for office in Yonkers last fall; Major J. H. W. Myrick, who addressed the diners on the subject of national preparedness for war; and M. W. Franklin.

On the last day of the meeting the ladies were taken to the Woolworth Tower and in the evening both members and guests went in a party to the Winter Garden to see "Dancing Around."

The entertainment committee, which was appointed from the New York chapter of the society, was made up of George G. Schmidt, chairman; C. E. Scott, C. A. Fuller, Homer Addams, J. I. Lyle, F. G. McCann, Perry West, W. H. Driscoll, W. F. Goodnow, A. S. Armagnac and Conway Kiewitz. Working with the chapter's committee were Secretary J. J. Blackmore and J. A. Donnelly, representing the society.

Inspection Trip to Laboratories of New York State Ventilation Commission.

Acting on an invitation tendered the members of Dwight D. Kimball of the New York State Commission on Ventilation to visit the commission's laboratories at the College of the City of New York, arrangements were made to go to the college in a body Friday morning. Mr. Kimball accompanied the party and on arrival at the college the members were shown the testing room in which studies have been made during the past year with different air conditions and with the subjects engaged in varying degrees of work. The methods and apparatus were explained in detail and an idea given of the further tests that have been planned.

Owing to lack of time it was not possible for the party to visit Public School No. 51, where the commission has fitted up two typical classrooms so that almost any desired air conditions can be obtained, with either upward or downward ventilation. This trip, however, was made the next day, and here the party was shown the equipment and the special apparatus, consisting of duplicate sets of fans and heaters and air washers which will be used for the tests, as well as the numerous air openings through the floors of the classrooms.

Illinois Chapter on Kitchen Ventilation.

"Restaurant and Restaurant Kitchen Ventilation" was the principal topic for discussion at the January meeting of the Illinois Chapter, which met January 11 in the Fraternity Room of the Great Northern Hotel. The meeting followed a chapter dinner and was called to order by President Charles F. Newport.

The topic of the evening was introduced by H. M. Harte. Mr. Harte showed how important the ventilation of hotel kitchens has become, citing the case of the Blackstone Hotel, in Chicago, where an 180-in. fan is kept running 20 hours a day to ventilate the kitchens alone. The La Salle Hotel in Chicago has a 160-in. fan which runs the same number of hours. Mr. Harte told of the present-day practice of building the kitchen exhaust flue like a stack so that, due to the accumulation of grease, it could be burned out periodically. He advocated a two to three-minute air change in restaurant and hotel kitchens.

EQUIPMENT MORE IMPORTANT THAN SIZE OF ROOM IN DETERMINING AIR SUPPLY.

Following Mr. Harte, the chairman introduced J. A. Anderson of the B. F. Sturtevant Company, who said that the important considerations in laying out a kitchen ventilating system was the number of kettles, steam tables, etc., rather than the size of the room. He also advocated a two to three-minute air change.

Another topic discussed at the meeting was "Defective Jobs and Practical Methods of Correcting Their Defects."

Secretary Bronaugh announced the election of the following to membership in the Illinois Chapter: D. I. Cook, J. J. Herlihy, Homer R. Linn, T. H. Monaghan, Alfred E. Stacey, Jr.; Ben Nelson and Richard S. Bull.

Secretary Bronaugh was officially named at the meeting as a delegate to represent the chapter at the annual meeting of the Heating Engineers' Society in New York.

Fighting Fire with Electric Fans.

We have all heard of fighting fire with fire, says *The Architect and Engineer,* but the use of electric fans as an adjunct of the fire department in putting out a blaze is surely novel.

In Boston, not long ago, a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick that it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone though of electric fans. A half dozen of the ordinary 16-in. size were quickly requisitioned by the fire chief and their breeze directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the effect of the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

LEGAL DECISIONS

Repairs on Heating Plant—Evidence as to Contract.

In January, 1911, a contract was entered into for the installation of a heating plant in a house, and the work was completed in April following. On January 3, 1912, the tank heater exploded and did certain damage. This was repaired by the contractor who installed the plant, who subsequently brought suit against the owner of the house for the cost of the repairs. The defendant made two claims. One was that the plaintiff furnished the material and labor without any contract and without expectation of pay in repairing damage done by reason of the defective work under the original contract of January, 1911. The other was that his house was injured by the explosion, and that the plaintiff was liable for the damage done, and for this he counterclaimed. That the plaintiff did the repair work was not disputed; the evidence conflicted as to any agreement to pay for it. The trial court substantially instructed the jury that the plaintiff was entitled to recover the amount of his claim, and that the verdict would depend upon the determination of the counterclaim for damages, which, according to the defendant's claim, exceeded in amount the defendant's claim. There was a verdict and judgment for the plaintiff for the full amount of his claim. On appeal this was reversed because, in instructing the jury as it did, the trial court proceeded upon the theory that there was an agreement to pay for the repair work necessarily implied. It disregarded the defendant's claim that the circumstances were such that the jury might infer that the work was done without expectation of pay, and because of a defective performance of the original contract. It was held that it was error to take this contention from the jury, because the jury, if it chose to accept the defendant's version, might conclude that the work done by the plaintiff in the repair of the heating plant was done without expectation of pay; or, in other words, the inference did not follow from the evidence as a matter of law that there was a contract. A "contract implied in fact" requires a meeting of the minds of the parties, an agreement, just as much as an "express contract"; the difference between the two being largely in the character of the evidence by which they are established. The general verdict for the plaintiff for the exact amount of his claim necessarily determined the defendant's counter-claim contrary to his contention. There was, therefore, no new trial of the counter-claim ordered, but only of the plaintiff's cause of action.—Lombard vs. Rahilly, Minnesota Supreme Court, 149 N. W. 950.

Finding That Heat Regulator Worked Properly.

In an action to recover a balance claimed to be due for the installation of a heating plant in the defendant's building by the plaintiff, the defense was that a regulator connected with the plant failed to properly regulate the heat. It was held that a finding for the plaintiff was sustained by the evidence.—Cahill vs. Dryden, 187 Ill. App. 413.

Praise for The Heating and Ventilating Magazine's Weather Charts.

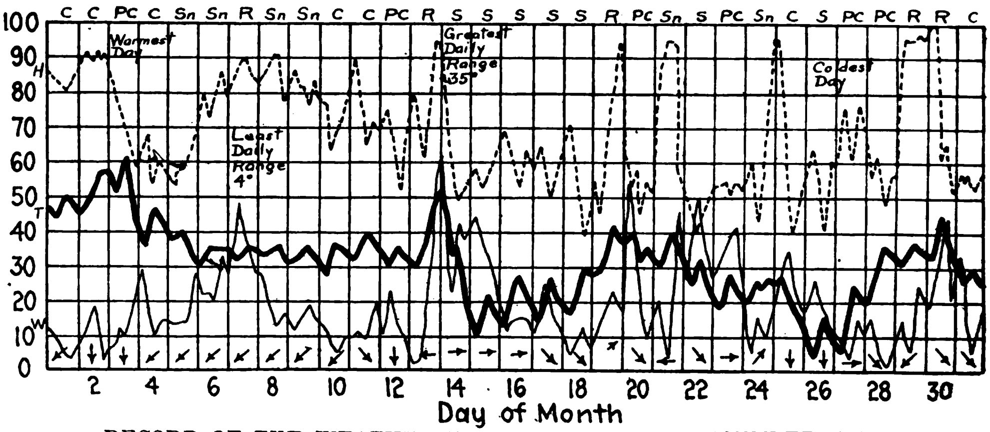
Under the title of "Graphic Methods for Presenting Data," by Willard C. Brinton, which has been running in the *Engineering Magazine*, of New York, the author presents many applications of curves and convenient methods of plotting curves. Among the examples which are shown is a typical weather chart taken from THE HEATING AND VENTILATING MAGAZINE. In speaking of this particular chart, Mr. Brinton says: "A large amount of information has been condensed into a small amount of space, yet the chart is fairly clear and easy of interpretation. Several ingenious combinations have been included, as for instance, the arrows that show the prevailing direction of the wind each day. The chart gives unusually complete information in a most convenient form for any ventilating engineer or power plant manager who wishes to keep careful track of his cost of coal in different months of the year, as dependent upon weather conditions."

Change in "Daily Consular and Trade Reports."

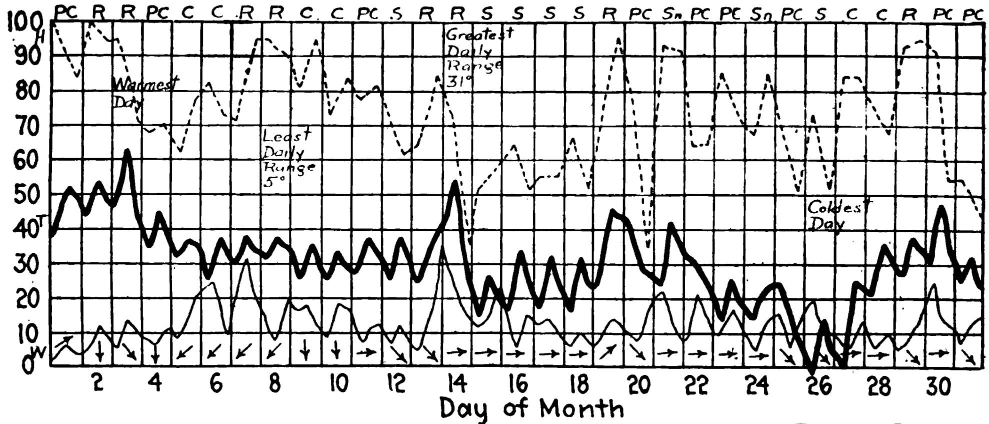
Announcement is made by the Department of Commerce that the name of its daily publication has been changed from "Daily Consular and Trade Reports" to "Commerce Reports." Heretofore this publication has been four days in the making. Henceforth "Commerce Reports" will be turned out at the government printing office within ten hours. Included among the contributors to this publication are 300 American consuls, ten commercial attaches, eight branch offices of the Bureau of Foreign and Domestic Commerce in as many important American cities, and numerous expert commercial agents in all parts of the world. The announcement is signed by Secretary William C. Redfield. "Commerce Reports" will be sent regularly to those requesting it, free of cost.

The Weather for December, 1914.

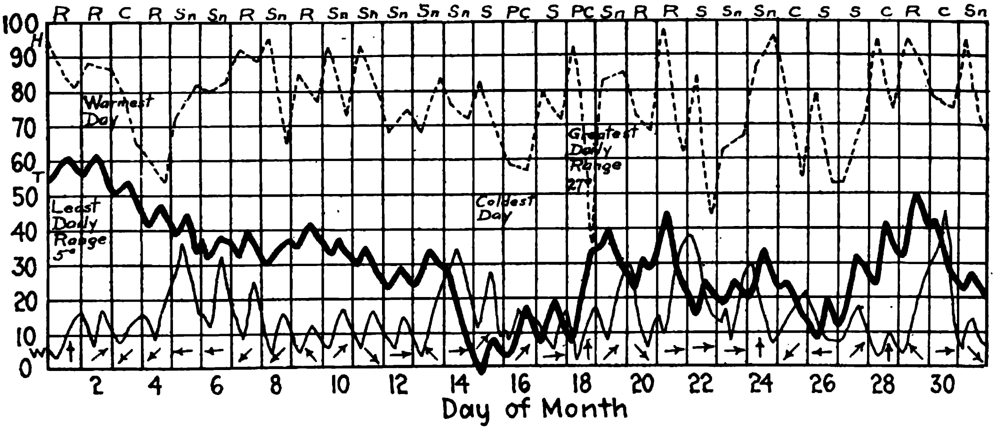
	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F..........	61	62	62	58	60
Date of highest temperature..........	3	3	2	1	1
Lowest temperature, degrees F	4	2	2	4	2
Date of lowest temperature..........	26	26	15	26	26
Greatest daily range, degrees F..........	35	31	27	24	21
Date of greatest daily range..........	14	14	18	30	24
Least daily range, degrees F..........	4	5	5	2	3
Date of least daily range..........	7	8	1	9	6
Mean temp. for month, degrees F..........	31.5	30	30	24.1	28.6
Normal mean temp. for month, deg. F.....	34.4	31.6	34.7	29.3	35.5
Total rainfall, inches..........	4	3.46	4.4	2.33	2.23
Total snowfall, inches..........	2.4	4.1	15.7	8.4	2.4
Normal precipitation, this month, inches..	3.45	3.41	2.73	2.07	2.23
Total wind movement, miles..........	12,511	8,575	8,808	10,253	8,619
Average hourly wind velocity, miles.....	16.8	11.5	11.8	13.8	11.6
Prevailing direction of wind..........	N.E.	W.	W.	W.	N.W.
Number of clear days..........	7	6	5	6	4
Number of partly cloudy days..........	7	11	3	7	7
Number of cloudy days..........	17	14	23	18	20
Number of days on which rain fell........	15	10	19	17	17
Number of days on which snow fell......	6	2	12	10	4
Snow on ground at end of month.........	—	0.2	0.1	3.7	—



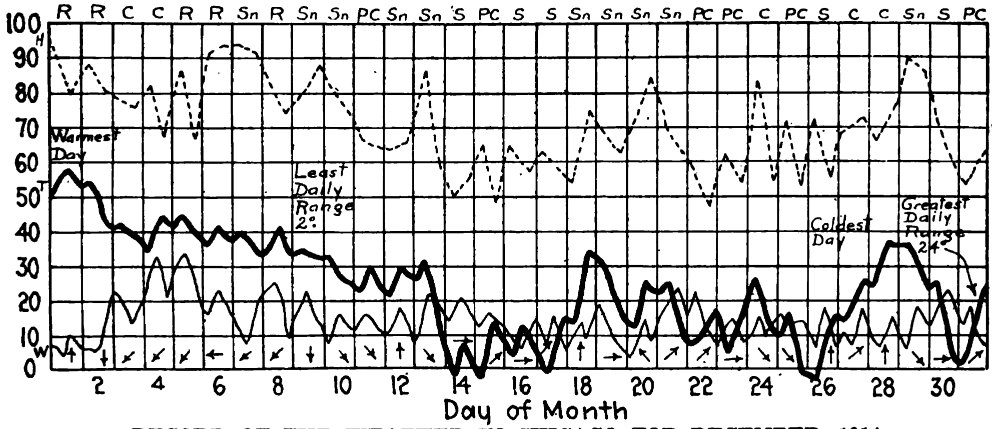
RECORD OF THE WEATHER IN NEW YORK FOR DECEMBER, 1914.



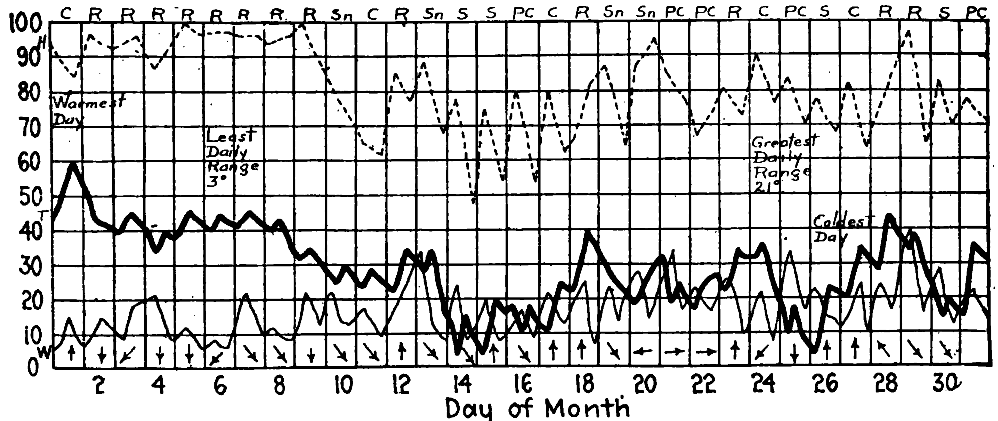
RECORD OF THE WEATHER IN BOSTON FOR DECEMBER, 1914.



RECORD OF THE WEATHER IN PITTSBURGH FOR DECEMBER, 1914.



RECORD OF THE WEATHER IN CHICAGO FOR DECEMBER, 1914.



RECORD OF THE WEATHER IN ST. LOUIS FOR DECEMBER, 1914.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

The European War as a Huge Fresh Air Experiment.

A fresh air talk was recently delivered by Prof. Leonard Hill, of London, in connection with the lecture delivered by Arthur H. Barker before the (British) Institution of Heating and Ventilating Engineers, as reported last month. Among the interesting things said by Prof. Hill on this occasion were the following:

"The first thing one needs to impress upon the people of this country is that the outdoor life is the right life for the human being. He has been evolved to live the outdoor life, and he can stand it as well as the cattle in the field. That the indoor life and the artificial heating of rooms is bad. Admitted that we have to do it because we have to do sedentary work, but sedentary work in heated rooms is essentially bad for the vigor and health of the human being. What it means is that if you keep yourself warm with clothes and with fires instead of living out-of-doors, you give out less calories, which means that you want less food —that you probably eat too much, which leads to bacterial decomposition in the bowels. It means, further, that we do not breathe so deeply as we should, so that part of our lungs are not properly opened, and this enables harmful organisms to enter our lungs. Further, our abdominal organs are not properly massaged. All these things come to pass because of our sedentary work in artificial conditions.

THE WAR: A HUGE EXPERIMENT.

"In this connection, one of the most notable experiments is taking place now owing to the war. Here we have an enormous number of men taken out of town life and put into camp life, living for five or six days in trenches half full of water, and exposed to wind and rain, but through it all well fed and clothed, and what is the result? I was at the War Office the other day looking at the returns and lists of those who were ill, and it was remarkable that there was not a single case of pneumonia or anything of that kind among the Kitchener army, save in one camp which was put in a thoroughly unhealthy place. From other camps there was not a case at all. Phthisis is an indoor disease caused by being shut up in heated and artificially ventilated places. Well, that has got to be worked into the people, and they have got to be made to understand that cold and damp do not cause illness, although they may cause discomfort and local pains by parts of the body getting chilled. Man is an outdoor animal, and he would never have survived the life he has had to live throughout his long evolution had he not the power to do so. We have the case of the curate who was on one of the cruisers which recently was sunk. He dived into the water and was there for two hours, and he is now none the worse for it. There is no evidence that the survivors of the Titanic got colds or pneumonia. These are infectious diseases, caused by our crowding ourselves together."

Dr. Hill, with the aid of diagrams, proceeded to explain the effect of heated air on the mucous membrane of the nose, and said the important factors in ventilation were temperature, humidity and velocity. He was convinced that one of the greatest evils of artificial ventilation was its monotony. The human being has a large area of skin, and was kept alive by the constant stimulation of the vast number of nerve ends in the skin by the varying temperature and the action of the wind. Out of doors there was always air-movement, and the cooling effect was always greater in the country than in the towns. Out of doors, owing to the earth being warm, the cooling effect was least at the ground level, which showed that the Romans, who warmed the floors of their dwellings instead of the air of the rooms, worked on lines nearer to nature than we do today.

Further Discussion of Standard Boiler Specifications.

A lengthy discussion of the report of the Boiler Specifications Committee of the American Society of Mechanical Engineers, at its annual meeting in December last, brought out the need of further revisions before the standards proposed will become generally acceptable. One of the suggestions made was that the requirements for heating boilers be segregated in a section entirely distinct from the power boiler rules, so that the particular requirements of this class of boilers can be adequately treated. This matter was referred to a representative committee of heating boiler manufacturers for further study. This committee is composed of Richard D. Reed, of the H. B. Smith Co., Westfield, Mass., representing the cast-iron boiler interests; M. S. Moore, of the Kewanee Boiler Co., Kewanee, Ill., representing the steel boiler interests, and Charles E. Gorton, of Gorton & Lidgerwood, 95 Liberty Street, New York.

Discussion of Radiation Formulas.

In a communication published in the January issue of THE HEATING AND VENTILATING MAGAZINE a comparison was made of different rules recently published in these columns for figuring radiation. It was shown that the results obtained from their use varied considerably. In connection with the formulas an explanation was given of the derivation of one of the formulas and below will be found

an explanation of the other one. In the communication referred to, the writer took a typical room 12x15x9 ft., with 12-in. brick wall, two 3x7 ft. windows with single glass, 12x9 ft. exposed wall with west exposure, having a heated room below and an unheated room above. He figured this out by the two rules referred to and also by the 2-10-200 rule.

In the first case, with the Gifford formula, the result was 77 sq. ft. of radiation. In the second case, with the Wilder formula, the result was 37.62 sq. ft. of radiation; and with the 2-10-200 rule, the result was 59 sq. ft. of radiation required.

In regard to the formula of Byron T. Gifford, Mr. Gifford states:

"I believe the following information will, to a certain extent, clear up the apparent discrepancy in regard to the varying results obtained. In the calculations referred to, which showed 77 sq. ft. of radiation required, it should be remembered that this refers to hot water radiation, while calculations made by the 2-10-200 rule are for low pressure steam heating. Ordinarily, low pressure steam heating will require approximately 60% as much radiation as gravity hot water heating. The constants used in my formula are for central station hot water heating and, in this case, low pressure steam would require about 70% of the amount of central station hot water heating. Seventy per cent of 77 sq. ft. of radiation is approximately 53.9 sq. ft. of radiation, which checks very closely with the results obtained with the 2-10-200 rule, without the additions for west exposure.

"Under the rules and factors which I outlined and which were published in THE HEATING AND VENTILATING MAGAZINE for November, 1914, I have considered the average exposure in the factors. This is due to the fact that the table was made up for central station hot water heating in Indianapolis, which is a rather flat city, and where the exposures are not exceptionally severe; also the fact was taken into consideration that the hot water plant in Indianapolis serves only the residence section.

"Your correspondent mentions his table as the 2-10-200 rule. As I have always understood this rule, it was known as the 2-20-200 rule. If that were the case, the radiation required for the room under his rule would be 12.3 sq. ft. less, or 46 sq. ft. of radiation. In the case of the calculations by the Wilder formula, if the additional radiation for exposure had been taken into consideration, I believe that the required radiation would be 10% more than that obtained, or 41.3 sq. ft.

The reason that the results by my formula do not check with the 2-10-200 results is that my formula is for hot water and the other is for steam. The reason that the results by the Wilder formula do not check with the 2-10-200 results is that the latter considers an exposure and is a thumb rule, which I would not consider accurate. The Wilder formula is based on the heat loss of the room and is more scientific and subject to better analysis than the 2-10-200 rule."

Inexact Statements in Manufacturers' Catalogues.

In these days it is becoming more than ever important that any appeal to an engineer regarding the merits of a manufactured product must be based on exact statements of fact. In the long run, half truths and distorted statements which may be accepted as fact for a time eventually reflect on the man who makes them and, if made by a responsible house, tend to lower the dignity of the whole engineering profession.

Our readers will no doubt recall many instances of this kind where the misstatements have been so glaring as to raise serious doubts of the good faith of the manufacturer. Of course, the apparatus or appliance itself, whatever its intrinsic merits, must suffer in the process. Very often the misstatements are merely inadvertent.

A typical instance of at least inexact statements is found in a recent circular detailing the merits of a return valve for steam heating. In discussing general physical laws the writer says in one place:

"One cubic foot of steam at 1 lb. pressure maintains a temperature 140° above the room temperature and condenses to 1/30 of one pint of water without change of temperature in radiating the amount of heat."

This is really a meaningless and involved way of stating a physical fact which would be true under all conditions and which does not affect the operation of the article advertised or of any similar article. The statement means that one cubic foot of steam at 1 lb. pressure has a volume of 1/1600 cu. ft. when condensed to water and at a temperature of 213° F. Also, that in condensing to water at the same temperature only the latent heat of evaporation is dissipated, or 970 B. T. U. per pound.

ACTUAL AMOUNT OF HEAT GIVEN OFF BY STEAM AT 1 LB. PRESSURE.

It would have been well to give the actual amount of heat that this cubic foot of steam would give off and then the reader could judge how short a time or how small a room this heat would maintain at any given temperature. It actually gives off 970 B. T. U. $\times 0.03806 = 37$ B. T. U. which means either a very small room or a very short time, about one second, for 1 sq. ft. of heating surface.

The writer was using intensities to convey the idea of quantity. We might have 100 lbs. pressure on a hermetically sealed tea kettle without accomplishing any work at all, or 2 lbs. pressure on a boiler utilizing 10 tons of fuel a day. The temperature pressure or intensity does not signify quantity but simply indicates a possible rate of doing work.

Another statement made in the same connection is that "this is cheaper and quicker than radiating the same amount of heat by lowering the temperature of the medium and handling many times the volume of return gas or water, as the case may be, when sensible heat is used."

If we assume the same volume of water, or 1 cu. ft. raised 5°, instead of a cubic foot of steam, in the same interval of time it would dissipate 300 B. T. U., instead of 38 B. T. U. as shown for the steam, or eight times as much. So the quoted statement is not correct as far as the supply pipe is concerned. Certainly a supply will have to be provided before the return can be utilized. The statement, as it stands, would tend to disparage the advantages of hot air and hot water heating systems, and yet, if taken literally, the hot air system would be better than a steam system, as it generally requires no return duct system at all.

NOTHING SAID ABOUT SUPPLY PIPES.

Nothing is said about the supply pipes and the statement would emphasize some important disadvantages in this connection. In hot water systems, the same size return is required as for the supply, while with the steam system, the supply is generally larger than for hot water. If the circulation of water is 1 cu. ft. per minute weighing 60 lbs., with a drop in temperature of 15°, the flow of the medium would give 900 B. T. U. per minute.

To get the same flow in the steam supply pipe, which is the comparison drawn in the statement, a pipe capacity of $900 \div 38 = 24$ cu. ft., or 24 times the area, at the same velocity, would be required.

This, on the other hand, is not a fair statement as concerns the steam, as no account is taken of the less density of the medium. There is not a great difference in the heat conveying capacities of steam and water supply pipes in heating. The less density of the steam is made up by the greater latent heat of condensation and, except in the case of high pressures, the water has the best of it as regards the supply pipe. This, it will be seen, is contrary to the meaning conveyed by the quoted statement.

If 5 ft. per second were taken for the velocity of the water, which is high, and 1 cu. ft. per second discharged with 15° drop, the capacity would be 900 B. T. U. per second. If 75 ft. per second were taken for the steam, which is low, a supply pipe to deliver the same heat capacity would require $(24 \times 5) \div 75$ or 1.6 greater area, which shows the error in the quoted statement.

Again, we read that "the friction in risers and mains due to replacement in the radiators of the steam condensed (when low pressures are maintained and where gravity assists the return water) is small, while in the case of one-pipe or two-pipe systems, the power is two great a proportion of the coal burnt."

TWO CONTRADICTORY STATEMENTS.

Here are two directly contradictory statements as from the nature of the requirements (the use of a return valve) a two-pipe system is a necessity. The size of pipes for the transmission of a given quantity of all fluids, including steam and water, is dependent on the difference in head or pressure which gives the velocity and, of course, the frictional resistance. On low pressure steam, with atmosphere as a limiting pressure, the velocities are low and pipes large, while the power to move is small. In all heating transmission systems, the great loss is by radiation and condensation, due to large diameters and circumferences, even when pipes are covered. The only loss in heat content is by radiation. High velocities give small circumferences and require greater power, but the heat resulting is returned to the medium and is not lost. This holds for both steam and hot water.

The circumference of a steam main 1.6 greater area than the water main would give an exposed surface 25% more for the steam main and, with higher temperatures, would result in a greater loss by radiation with steam, reduced by the amount of the return on the water main over the size of the steam return. In long transmission lines the most economical method of operation is with large drops in pressure, high velocities and small mains. It is possible to reduce the loss so that no condensation will be removed and dry or superheated steam may be obtained at the end of the line. This again does not apply to the particular case in question, but general principles of physics should be used with care when applied in part to the use of particular apparatus.

VOLUME OF STEAM AT DIFFERENT TEMPERATURES.

Another statement is that "the same weight of steam occupies ten times the radiation at 1 lb. as it does at 10 lbs. pressure, while the temperature is only 240° F. as against 212° F. The latent heat is actually 20 units less than at 10 lbs. pressure and the coal burnt is much more."

The volume of steam at 212° is, per pound weight, 26.8 cu. ft. and at 240° F. and corresponding pressure, is 16.32 cu. ft. per pound,

so that the relative spaces occupies are 26.8÷16.32 or 1.66 cu. ft. at 212° to 1 cu. ft. at 240° and not 10 to 1. Also, if the temperature of the surface is 240° F., instead of 212°, and the room is 70°, the heating surface in radiation may be reduced as (240—70)÷(212—70) or 170÷140 or 20% less surface will be required on 240° to do the same work.

Except in extreme cases of high flue temperature the gases seldom require more than 15% of the total heat of the fuel, even when high pressures are carried. Therefore, it is hardly correct to state that a greater amount of fuel would be required to do the same work. Of course, this assumes no waste in either case. Certainly, the same size boiler would do the work in either case if the radiation were reduced in proportion to the difference in temperature corresponding to the pressures and temperatures named.

If the steam actually occupies ten times the space for 1 lb. over 10 lbs. pressure, a supply main ten times the area would be required, if the same velocity were maintained, in either case. It is true that steam at 10 lbs. pressure has a latent heat 20 B. T. U. per pound less than at 1 lb. pressure, but the total heat is greater, as well as the sensible heat. The total heat in steam above 32° F., at 212° and 0 lbs. pressure, including sensible and latent heat, is 1,150.4 B. T. U. per pound, and at 600 lbs. pressure, or the other extreme of the scale, it is only 1,210 B. T. U. per pound, or a difference of 60 B. T. U. The latent heat varies from 970 B. T. U. at 212° to 762 B. T. U. at 600 lbs. and the sensible temperature varies from 212° to 486° F. These physical facts have little or nothing to do with the appliance which the statement referred to, as affecting the advantages of operation.

SIZES OF PIPES AND FITTINGS.

The statement is made that "in two-pipe, low-pressure steam systems, with water only in the returns, smaller piping, fittings and radiators can be used." This is incorrect as with a lower pressure steam larger supply mains are required due to the greater volume as shown by the statement that steam at 1 lb. pressure occupies ten times the volume of the same quantity of steam at 10 lbs. pressure and the writer's comments on same. As the temperature of the steam determines the size of the radiators, larger surfaces would be required, due to the lower temperatures.

There is never any solid water in the returns of a properly-installed steam job, either one or two pipe, as water hammer would result. The actual conditions of the steam is one of quality containing entrained water which may run up to 40 to 50% quality of steam.

At the present time heating apparatus may be made to work economically and satisfactorily with hot air, hot water, high or low pressure steam or any combination, one or two pipe, as desired. The only differentiations for various requirements in practice are along the lines of the relative costs of installation versus those of operation and maintenance, and generally the higher the cost the less the cost of operation and maintenance.

Testing Radiators in Temperatures Above Zero.

In testing out the heating system of a large railroad terminal, it was found that the radiation in the waiting room was sufficient to heat the room to 70° F. when the outside temperature was 30° F. The system has been guaranteed to heat all rooms to 70°, with an outside temperature of zero, but it would seem from the above-mentioned test that the guarantee cannot be fulfilled. The problem is to find the temperature of this room when the outside temperature is at zero. The waiting room contains 2,200 sq. ft. of direct radiation, of which 800 sq. ft. is wall radiation and 1,400 sq. ft. is contained in five 3-col. radiators 42 in. high.

The current of air around the surface of a radiator increases in temperature as it passes through the columns of the radiator, or as it rises along its sides. The temperature difference between the steam in the radiator and the air is, therefore, reduced. As the transmission of heat units depends upon this difference in temperature, it follows that a single-column low radiator has the greatest efficiency.

With steam at a temperature of 220° F. and the room at 70° F., the temperature difference is 150°, these conditions being accepted as standard. The factor of transmission will vary approximately 2 per cent for each five degrees of variation from the standard; if less, the transmission will be less, and if more, the transmission will be greater.

The conditions as outlined in the preceding paragraphs affect the solution of the problem under consideration. The B.T.U. transmitted per sq. ft. per degree difference in temperature per hour for a temperature difference of 150° F. is 1.9 B.T.U. for wall radiators having vertical loops, and 1.5 B.T.U. for a 3-col. radiator 42 in. high.

Total wall radiator transmission = 800 sq. ft. × 1.9 × 150 = 228,000 B.T.U.

Total circular radiator transmission = 1,400 sq. ft. × 1.5 × 150 = 315,000 B.T.U.

Total transmission, 228,000 + 315,000 = 543,000 B.T.U.

The total transmission from the radiation of 543,000 B.T.U. is lost through exposed surfaces of the building construction and by air change, this being the number of heat units that must be given off to heat the room to 70° F., when the temperature difference between the inside and the outside of the room is $70 - 30 = 40°$ F.

543,000 B.T.U. $\div$ 40 = 13,575 B.T.U. lost through exposed walls and by air change for each degree of temperature difference between the air in the room and that outside.

Let x = temperature of room when the outside temperature is zero.

Then $13{,}575\,x =$

$$[(1.9 \times 0.02 \frac{(220 - x - 150)}{10} + 1.9)\ (220 - x)\ 800] + [(1.5 \times 0.02 \frac{(220 - x\ 150)}{10} + 1.5)\ (220 - x)\ 1400]$$

= heat given off by the total radiation installed per hour when the outside temperature is zero and the temperature of the room is x.

$13{,}575\,x = [(2.166 - 0.0038\,x)\ (176000 - 800\,x)] + [(1.71 - 0.003\,x)\ (308{,}000 - 1400\,x)]$

$13{,}575\,x = [(3.04\,x^2 - 2401.6\,x + 381216)] + [(4.27\,x^2 - 3318\,x + 526680)]$

$13{,}575\,x = 7.24\,x^2 - 5719.6\,x + 907896$

$-7.24\,x^2 + 19294.6\,x = 907896.$

Divide each side of the equation by 7.24. Then $-x^2 + 2665\,x = 125400.$

Changing the signs and adding to each side of the equation the square of one-half the number before x makes this a quadratic equation.

$x^2 - 2665\,x + (2665 \div 2)^2 = -12544 + (2665 \div 2)^2$

$x - 1332.5 = \sqrt{-125400 + (2665 \div 2)^2}$

$x - 1332.5 = \pm 1284.5$

$x = 1332.5 - 1284.5.$

$x = 48°$ F., the temperature of the room with an outside temperature of zero.

The Engineering Foundation.

The inauguration of the Engineering Foundation was effected January 27, at the Engineering Societies Building, New York. The Engineering Foundation is a name given to a fund to be administered for the advancement of the arts and sciences connected with engineering and the benefit of mankind. The basis of the fund is a gift of no less than $200,000 donated by Ambrose Swazey, a former president of the American Society of Mechanical Engineers. The participants in the use of the fund will include the United Engineering Societies and also the American Institute of Civil Engineers.

"Made in the U. S. A." Exposition in New York.

The first national "Made in the U. S. A." industrial exposition will be held in the Grand Central Palace, New York, March 6-13, 1915. The object of the exposition will be to show a comprehensive exhibition of "American made" and "American grown" products. Among the exhibitors will be the United States government, and the Postoffice Department. The City of New York will also have an exhibit.

An Electric Steam Radiator.

An electric steam radiator, whose cost of operation is no more than that of a gas radiator, has been brought out by the Automatic Electric Heating Co., 2330 Market Street, San Francisco, Cal. It is operated as a vacuum-vapor heater and is made air tight for this purpose. The radiators are portable and are of the standard sizes. They are made either of cast-iron or pressed metal.

To operate the radiator, the socket is fastened to the lamp or wall plug and the current turned on. The radiator is automatically controlled.

New Publications.

THE ANALYSIS OF COAL WITH PHENOL AS A SOLVENT by S. W. Parr and H. F. Hadley, is a new publication (Bulletin No. 76) of the Engineering Experiment Station of the University of Illinois. The bulletin is illustrated with views of the apparatus used and photographs of the coals taken at different periods of the test. In the summary of results it is stated that:

1. Phenol at 100° C. will dissolve certain constituents of bituminous coals in their natural state. The two subdivisions, designated as *insoluble residue* and *extraction material*, together make substantially 100% or the amount of the original substance.

2. The amount of extractive material is def definite and susceptible of quantitative determination.

3. Studies upon these two type substances indicate that the extract is the vital constituent concerned in the coking of coal. It conforms to the principle already enumerated in that it has a sufficiently definite melting point and a decomposition temperature which is above that of the melting point.

4. Each subdivision is capable of absorbing oxygen. The effect upon the extract is to modify its coking properties by lowering or greatly reducing its power to form a firm and coherent mass.

5. The oxygen taken up in either case is found to be chemically combined. The oxygen taken up by the fresh coal is similarly

held. The insoluble portion has the greater avidity for oxygen. This relation to oxygen has a bearing upon other topics aside from that of coking, as the heating of coal in storage, spontaneous combustion, weathering, and deterioration.

TESTS ON HEATING AND VENTILATING, made under the directions of Dr. K. Brabbée at the Imperial Technical High School at Berlin are described in pamphlets recently published by our Germany contemporary, *Gesundheits-Ingenieur* (R. Oldenburg), Berlin. These pamphlets show the knowledge our German colleagues have of the science of the profession, and the thorough manner and detail with which research work is carried on. Unfortunately the pamphlets received describe mostly tests made on apparatus not used in this country. Nevertheless, the description of, the method of performing and the results of the tests are interesting.

pipe connected to the outlet of a Strebel hot water boiler, three expansion lines were run, and on these the tests were made. These pipes were of 25, 34 and 39 mm. diameter (approx. 1 in., 1¼ in. and 1½ in.) and ran up in a vertical distance for about 80 ft. At a height of 40 ft. tees and branch pieces were inserted and also in each line was connected, in series, a coil. Valves were placed in the different branches so that tests could be made with either of the three pipes, each of the two different heights, and with or without the coils, as desired. Pressure readings were taken for the different cases, and for various boiler sizes. From the observed pressure readings and corresponding load on boiler, curves were plotted for the different conditions. From these curves and for the worst condition, the following table was made. The table is copied, the nearest equivalent in the English system being added.

*Sq. ft. of Radiation	Fire Surface of Boiler sq. ft.	Fire Surface in Boiler sq. m.	Dia. of Pipe mm.	Nearest of Pipe in inches
Up to 870	Up to 43	Up to 4	25	1
Over 870 to 2160	Over 43 to 108	Over 4 to 10	34	1¼
2160 to 3220	Over 108 to 161	10 to 15	39	1½
3220 to 6020	161 to 301	15 to 28	49	2
6020 to 9046	301 to 452	28 to 42	57	2½
9040 to 13000	452 to 646	42 to 60	64	2½

Pamphlet No. 4 describes tests made on a so-called Schlotter fan of the disc type by Dr. K. Brabbée and Dr. M. Kloss, professors at the Berlin Technical High School. This is a type of an having stationary guide vanes on the pressure side.

Pamphlet No. 5 describes a series of tests made by Franz Werner on certain types of steam radiators used in modulating systems. The modulating effect is produced by the mixture of steam and air as in the types of radiators used in the systems of Käferle and Körting. The distribution of the temperature, both for the surface and the interior, was first determined for each section of an ordinary radiator. Tests were made under different steam pressures, and for both top and bottom steam supply connections. Curves are plotted showing the temperature for the various points measured in each section under various working conditions. Similar observations were made on a patented radiator, also on the type of radiators used in the Käferle and Körting systems. Tests were also made on the transmission coefficient and on the pressure loss.

Pamphlet No. 6 describes tests made on safety devices for hot water heating boilers. Observations were first made to determine the size of expansion pipes required for different sizes of heating systems. From a short

(* As it is not customary in the United States to rate heating boilers in heat units and fire surface a column is added giving the ratings in square feet of radiation. The rate of transmission varies according to the disposition of the fire surface, and it may be anything from 2,500 to 5,000 B. T. U. per square feet. A good average for the majority of boilers would be about 3,000 and this figure was used, which divided by 150 gave the rating in square feet of radiation. The smallest size given —25 mm.—is slightly less than 1 in. It is the practice in this country to use ¾ in. for small work.)

The above were supplemented by test made on a type of two-way valve used on hot water systems as a safety device. The method of testing is described and a series of curves are plotted. The size of valve to be used for different sizes of heating systems is also given.

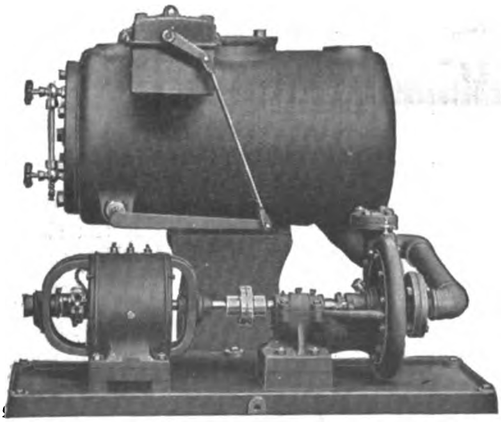
SCIENTIFIC MANAGEMENT, a collection of the more significant articles describing the Taylor system of management, has been published as Volume 1 of Harvard Business Studies. It was edited by Clarence Bertrand Thompson, LL., B., A.M., lecturer on manufacturing in Harvard University. 8vo. Cloth. 878 pages, with diagrams and illustrations. Price, $4.00, and may be had through the book department of THE HEATING AND VENTILATING MAGAZINE.

VENTILATION OF FARM BUILDINGS is the title of a recent bulletin prepared by J. H. Grisdale, B. Agr., Director of Dominion Experimental Farms, and E. S. Archbald, B. A., B. S. A., Dominion Animal Husbandman. It is issued as Bulletion No. 78 of the regular series of the Experimental Farm Bulletins, published by the Dominion's Department of Agriculture, Ottawa. The bulletin includes an illustrated description of the Rutherford system of ventilation.

NEW DEVICES

Beach-Russ Automatic Condensation Pump and Receiver.

An interesting type of automatic condensation pump and receiver has recently been placed upon the market by the Beach-Russ Co., 220 Broadway, New York. This apparatus is especially designed to remove the condensation from steam heating systems, dry kilns, etc., and to automatically return the water to low pressure boilers. The pump has its suction connected to the receiver direct, into which the condensation from the heating systems flows by gravity and the discharge is connected with the boiler. The float within the receiver automatically starts the pump when the receiver becomes full and stops it when the receiver is emptied. The company



BEACH-RUSS AUTOMATICCONDENSATION PUMP AND RECEIVER.

manufactures two lines of these condensation pumps and receivers, one series for boiler pressure running from 5 to 15 lbs. and the other for pressures from 15 to 30 lbs. In each case the capacities range from 16,000 sq. ft. to 100,000 sq. ft. of radiation. The manufacturers emphasize the fact that their standard pumps are fitted with bronze impellers and have bronze shafts.

A Steam Generator and Indirect Radiator Combined.

A product that is described as something new and unique has lately been brought out in the shape of a steam generator and indirect radiator combined as one unit. This apparatus is manufactured and sold by the

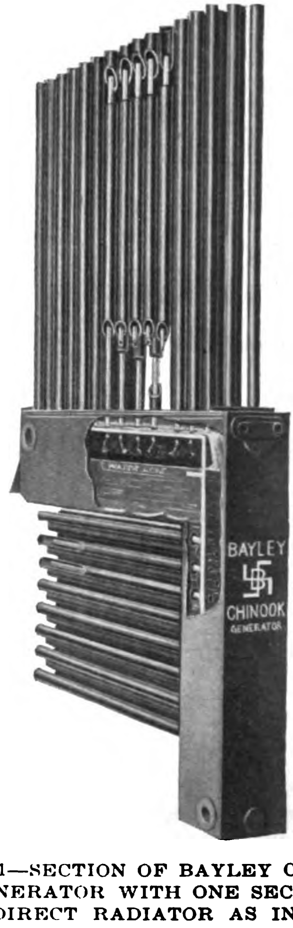


FIG. 1—SECTION OF BAYLEY CHINOOK GENERATOR WITH ONE SECTION OF INDIRECT RADIATOR AS INTEGRAL PART OF GENERATOR.

Bayley Mfg. Co., Milwaukee, Wis., and the accompanying illustrations indicate the principle upon which the generator is built.

Fig. 1 shows one section of the generator with one section of the indirect radiator as an integral part of it. The illustration has been broken away so as to give an interior view showing the water line, steam space, circulating tubes, travel of steam and return of condensation. As steam is raised, it rises directly into the radiator and, when

condensed, falls by gravity into the generator, thus setting up a continuous and unending cycle so long as there is sufficient heat applied to make steam or vapor.

Fig. 2 shows five of these sections grouped and connected, as one unit, by through bolts, fitted with copper gaskets. This illustration is also broken away to show the furnace construction, travel of gases, smoke box extension, etc. The furnace is of the Dutch oven type, made sectional of heavy gray iron castings, lined first with heavy asbestos board and then with fire brick. The arch is of cast-iron in sections, lined with asbestos and fire brick, while the grates are of the rocking and dumping type.

The generator tubes are made of steel, enclosed at the outer end by a plug welded in. The radiator tubes are of the same construction. In both generator and radiator, circulation is obtained through a pipe within a pipe. The outer end of the generator tubes are unsupported and are accessible for cleaning through removable cover plates, as shown. The smoke box extension is of cast-iron, built in sections.

Included in the trimmings are safety valve, damper, regulator, steam gauge, water column and water connection and blowoff openings. With this device there are no steam and drip connections, no return water apparatus and no pipe covering required.

The manufacturers lay emphasis on the point that the Chinook generator, as the apparatus is called, is a safety device, as it is built on the water-tube principle. Also that its compactness permits of its installation where the standard arrangement can not be utilized. It is also stated to be highly efficient; that is, economical in the use of fuel, because of the type of furnace used and because of the fact that there are no radiation losses from steam and drip connections. The water of condensation is returned to the generator at the temperature of the steam. It also does not require a skilled and high-priced attendant, but can be operated by one of average experience.

The Chinook generator was primarily designed to meet the requirements of the small types of buildings, such as schools, churches, theaters, and factories, and for indirect heating only, but it has been found feasible to supply direct radiation as well, in connection with an indirect system, for large buildings.

A blower is used in connection with the generator and a by-pass provided over the indirects. This is to allow cold air, tempered air or hot air to be delivered at will.

With this system it is found that a constant air supply and uniform temperature can be maintained at all times, meeting the requirements of health, as well as those of State laws and city ordinances.

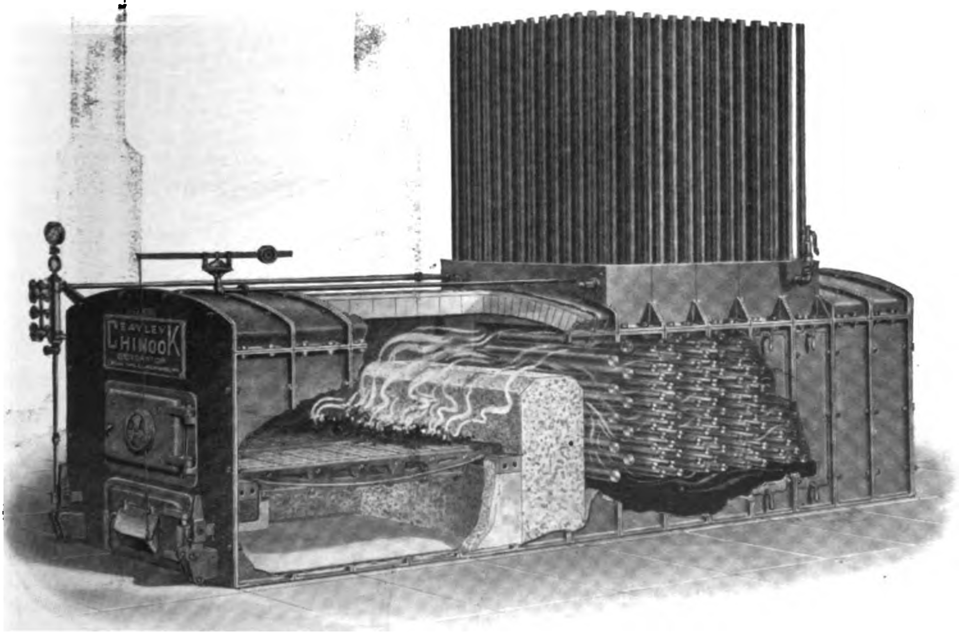
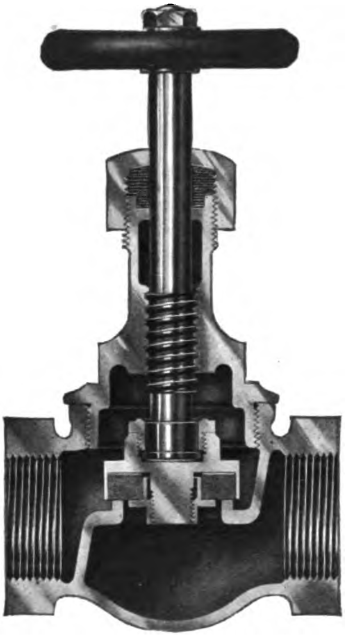


FIG. 2.—FIVE SECTIONS OF BAYLEY CHINOOK GENERATOR GROUPED AND CONNECTED AS ONE UNIT.

A New Jenkins Bros. Disc.

A new composition disc for steam valves has recently been perfected by Jenkins Bros. in their rubber factory at Elizabeth, N. J., which, it is announced, will be used hereafter in all Jenkins Bros. standard pattern globe, angle, cross and radiator valves. The company states that the fact that it was the first



JENKINS BROS.' VALVE WITH NEW NO. 119 DISC.

in the field with the renewable composition disc has afforded the necessary practical experience so difficult to obtain except through years of experience to improve the disc compound which is now being marketed.

The new disc will be known as the Jenkins Bros. disc No. 119. The composition is notably hard, but is designed to become tough and flexible in service when under steam pressure. It has been shown to have remarkable freedom from cracking and flaking and

THE NEW JENKINS BROS.' DISC NO. 119.

to have the desired durability in working steam pressures up to 150 lbs. During the past year the disc has been undergoing severe tests in hundreds of plants and engineers who are now using the No. 119 disc are quoted as pronouncing it the most satisfactory disc for steam service ever brought to their notice.

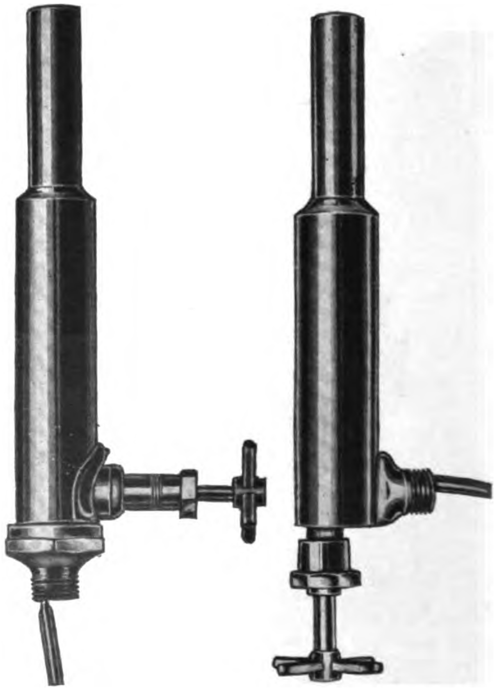
The disc is backed by the Jenkins Bros.' guarantee, which has always covered this company's products.

The manufacturers state that a complete service department is maintained to assist those in doubt to procure the proper valve or disc for the proper place. This department is at the disposal of all purchasers of Jenkins Bros.' products without cost. A sample disc may be had free of charge by addressing the manufacturers.

The Steamo Air Moistener.

A humidifying device for supplying the necessary humidity to the air of rooms, including factory and industrial quarters, has lately been placed on the market by the Air Moistener Co., 28 North Market street, Chicago, Ill. This device, as its name implies, operates by admitting steam directly into the air and is notable in that it is noiseless in operation. It is also stated to be automatic so that when once adjusted it requires no attention.

The Steamo air moistener is intended to take the place of the pans and other receptacles of water placed on radiators. Heretofore the use of steam for humidification has not been satisfactory on account of the hissing noise that accompanies its escape



For Attachment to Heating System Independent of Radiator. For Attachment to Steam Radiators.

TYPES OF THE STEAMO AIR MOISTENER.

from the radiator, to say nothing of the dripping of water that required that it be either collected in a pan or else allowed to drop on the floor. The Steamo air moistener embodies a new principle which is intended to overcome these troubles and allow the steam to issue from it silently in a soft cloud, with no dripping of water. It is an attractive-looking nickel-plated instrument, for attachment to the end of the radiator, or to the heating system independent of the radiator and is designed to discharge vapor into the room as long as there is steam in the radiator. The amount of vapor discharged is regulated by a valve at the bottom, or the flow may be shut off entirely, if desired.

This device is made in a number of sizes. Some of them are made for attachment to the steam piping independent of the radiator. These, it is stated, are the styles which eventually will be employed in new work, as it is desirable that the humidification be independent of the heating, so that the temperature will conform to the condition of the moisture. In the use of the larger sizes, such as those for large rooms housing many people, or those that are devoted to some industrial process where humidity is essential, it is noted that the amount of steam discharged is so great that a current of air must be directed across the outlets to absorb the vapor. For this purpose an electric fan is usually used. In a newly-issued catalogue devoted to this device, the manufacturers give a table for calculating the size or number of air moisteners required for any given condition.

ADVERTISERS' INDEX

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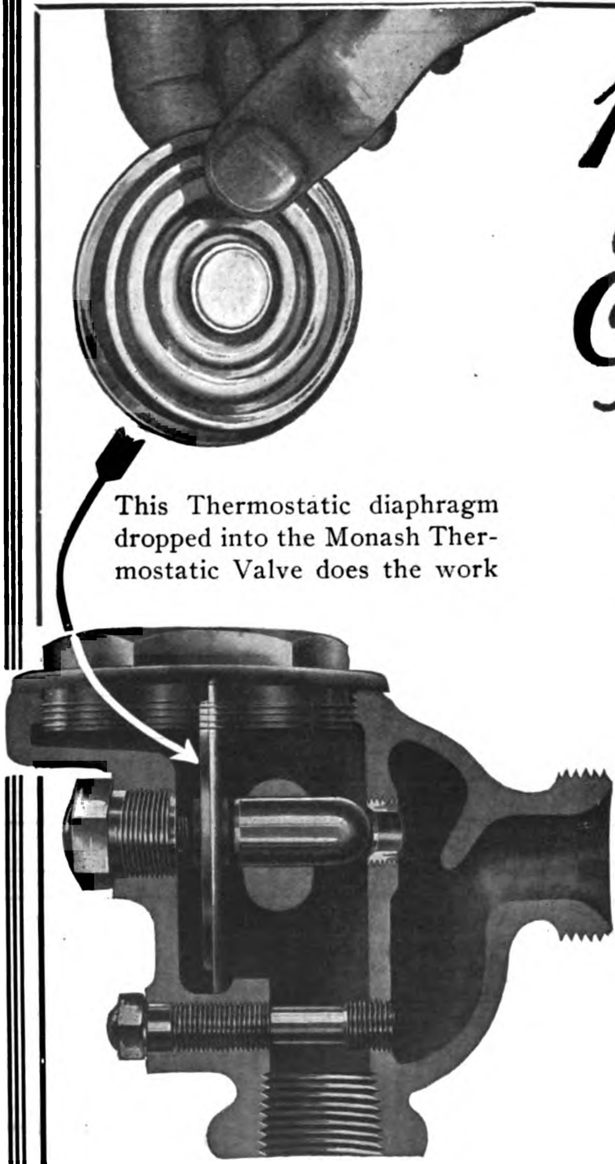

This valve has a loose thermostat which is not attached to the cover or body of the valve and **requires no adjustment.**

It has a spring bumper to take care of the over-expansion of the thermostat and prevent its collapse or rupture.

U. S. Patent, April 28, 1914

MONASH THERMOSTATIC RETURN LINE VALVE

for

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THE HEATING AND VENTILATING MAGAZINE

1123 Broadway · NEW YORK · March, 1915

The Relation of the Architect and the Engineer

By D. D. Kimball.

President, American Society of Heating and Ventilating Engineers; Member, New York State Commission on Ventilation.

(*Read before the Pittsburgh Chapter, American Institute of Architects, and here first published.*)

Twenty-two years in engineering work and in constant association with architects and architectural practices has brought to me a realization of the great divergence in views among architects concerning the engineering phase of the architect's work, especially regarding the necessity of employing an engineer, the method of the selection of the engineer, the relations of the architect and engineer during the planning and the execution of the work, the owner's liability for payment (in whole or in part) of the extra cost of engineering services, and on all matters relating to the domestic equipment of large buildings.

The subject is especially timely because of the ever-increasing demand on the part of owners and the occupants of buildings for variety of service, because of the multiplication of equipment available, and because of the entire lack of any accepted method of procedure.

The subject is of the utmost importance to owners and architects because it involves the success of nearly all large structures, be they office buildings, churches, theatres, hotels, hospitals, factories, mercantile establishments or what-not.

PREVAILING PRACTICES.

The first consideration in plan making is the provision for a building having suitable spaces for all purposes; the second essential is that the building shall be structurally sound; the third is that it shall be esthetically satisfactory, and the fourth requirement is that it shall be made habitable by the installation of adequate heating, ventilating, lighting, sanitary, refrigeration, elevator, vacuum cleaning and general domestic equipment.

The first three requirements may be considered as constituting the structure, and the fourth item, to which this treatise is devoted, as constituting the equipment of the structure. The architect is, presumably by training and experience, capable of preparing plans and specifications for the erection of the structure. The problem, then, is that of the method of procuring the plans and specifications for the equipment of the building.

Very few architects have, as members of their staff, competent heating, ventilating, electrical and sanitary engineers. The fact of the matter is that a vast amount of architectural work is required to warrant the maintenance of an engineering department. Unless a high grade

of engineering talent is employed disastrous results are sure to ensue. Further, where the maintenance of an engineering department is dependent upon the work of one architect's office only, it is very difficult to maintain such a volume of work as will keep the engineers busy at all times, and, unless this can be done, the engineering department becomes expensive to maintain, while to alternately employ and dismiss such engineers is manifestly unsatisfactory and expensive. However, where the architect has sufficient work to warrant the establishment and maintenance of an engineering department the advisability of so doing may not be questioned.

Many of the large architectural offices employ consulting engineers for the preparation of the plans and specifications and the supervision of the installation of the equipment. Undoubtedly the best and most varied talent can be secured at the least cost in this way. Mention need hardly be made of the importance of selecting engineers having a thorough organization, a long and wide experience, a well-recognized standing, and no contracting or manufacturing interests.

Another method of procuring plans and specifications for the domestic equipments is that of allowing a number of contractors to submit plans and specifications for such work in competition. This method, however, is but little used (unless it be for small country school houses), and fortunately so, for no more iniquitous scheme could be devised. It merely puts a premium upon the cheapest thing possible, which is usually the least efficient, and it almost inevitably results in the practice familiary known as "skinning the job."

THE PREPARATION OF PLANS BY CONTRACTORS AND MANUFACTURERS

The method, which unfortunately, is still most in vogue for procuring plans and specifications for equipment is that of allowing some contractor or manufacturer, or an engineer in the employ of a contractor or manufacturer, to prepare, usually without charge, the plans and specifications for this work. The result of this course, and the following statement will be verified by every experienced observer in the engineering profession or trades, is that in nine cases out of ten the contractor who gives this service is the one who becomes the successful bidder, or the manufacturer who makes the plans secures the order for that portion of the work in which he is interested. This fact explains why the contractor and manufacturer are so willing to prepare plans and specifications, which are often very expensive. If further reason were necessary it exists in the contractor's natural desire to secure and maintain the good will of the architect, which he does by supplying a real need of the architect and by relieving him of a large item of expense. Then do not forget that the contractor and manufacturer are engaged in the business of selling materials.

As a modification of this plan an agreement is sometimes entered into between the architect and contractor whereby the contractor shall be paid a small fee, say one-half to one and one-half per cent., if he should fail to be the successful bidder, and nothing if he is successful. This is unfair to owner, architect and contractor. It would be just as fair to the owner, except in point of degree, to allow a building contractor to draw the general construction plans for the building on the same basis. Independent expert services are not secured, the architect is placed under embarrassing obligations (or else is regarded by the contractor as lacking in appreciation and loyalty) and the contractor renders the service at less than cost for the same reason that on other occasions he renders the service without charge.

Such contractors' engineering has proven to be the most prolific source of padding of plans and specifications and pooling of bids.

If the architect were capable of passing judgment on the suitability or the efficiency of the plans made by the contractor, on the quality or quantity of materials provided or on the capacity of the apparatus he would not be obliged to use such services in the making of plans and specifications.

An architect may admit that the use of contractor's plans is not the best, or even a correct method, while insisting that if the owner will not pay the extra cost of

engineering services, the owner must take such services as the architect can procure without extra expense. This attitude ignores entirely the fact that that for which the owner pays is independent, expert service and that, in so far as the architect uses a self-interested party in fulfilling his obligations to the owner, he is not carrying out the spirit of his employment.

AN IMPRACTICAL SUGGESTION.

Observe this architect's suggestion of a method of obviating the danger of securing imperfect work when using contractor's plans. Speaking before a contractors' association the necessity was voiced of some sort of a guarantee of the efficiency and quality of the work of the contractor installing the work. The suggestion was made that the contractor's association should have a committee of experts to whom the architect could look for advice, which committee should state in an impartial way whether the contractor had fulfilled the terms of the contract. Should the committee find that the contractor had done shoddy work he should be subjected to punishment by the association, even to the extent of banishment therefrom. Could anything be more absurd? It is certain that this particular architect knows nothing of the cohesive force of a contractors' association.

It can scarcely be disputed that the owner employing an architect does so for the purpose of securing independent expert service, nor can it be disputed that the architect who permits a contractor, with or without pay, to prepare his plans and specifications for the equipment of a building does not render the independent service for which he receives pay. In employing or allowing a contractor to prepare plans and specifications for the domestic equipment the architect, in effect, admits his inability to produce such plans and specifications. Inability in this respect carries with it inability to supervise the installation. Thus the owner and the architect are entirely at the mercy of the contractor. No amount of guarantees required of the contractor will alter this fact.

I venture to assert that there is an element of impropriety on the part of an architect who receives payment for plans and specifications for an equipment which involve knowledge or ability which the architect or a member of his staff cannot furnish, or in other words, accepts pay for plans and specifications which he cannot furnish independently of manufacturing or contracting interests.

TRAINING AND EXPERIENCE OF THE ARCHITECT AND THE ENGINEER.

Architecture is an art of centuries of development and training. Domestic engineering is a modern science. The training for one is not adaptable to the other. As the construction of buildings gradually emerged from those involving merely masonry and carpentry work to the complicated structures and equipments of today the architect was called upon to assume the responsibility for that which was involved in each step of progress, until now the development has reached a point where the conscientious architect realizes that certain things are beyond him, and the owner, for his own good, should realize this.

I submit that architects are not engineers, either by temperament, training or experience. Architecture involves design and plan structure and stability, esthetics and orientation. It has to do with materials which are inert and which will develop his plans, promote strength and give beauty. These requirements involve a long and thorough education and special training and experience. If the engineer is also temperamental it is of a prosaic nature, and little of the esthetic is involved or required. His training, while long, complex and thorough, is of an entirely different nature. His training and work involve the study and utilization of moving elements, such as air, water, steam, electricity and other manifestations of power or potential forms thereof. The architect has to do with the comfort and health of the occupants of the building in their use thereof, and the economy of operation and maintenance.

It is doubtful whether the country or the times have yet produced a man who, in himself, is a master in both branches of work, and as the requirements along all lines continue to grow apace the possibility of the coming of such a man becomes more and more remote. This is essentially the day of specialization.

THE FUNCTIONS OF THE ARCHITECT.

In considering the functions of the architect the discussion will be confined to those which are more or less related to engineering, or are more or less involved in the relation of the architect and the engineer, and we will assume that the architect employs the consulting engineer.

It is manifest that there should be some one person or firm responsible for the delivery to the owner of a complete and thoroughly-equipped building, and it is logical that the architect should be the one to assume this responsibility. To provide such plans and specification as will accomplish this the architect or his assistant must give of his time for consultation with the engineer or his assistant. There should be a thorough discussion of all matters pertaining to the equipment of the building.

The architect must so arrange his plans as to provide spaces for coal, boilers, auxiliary apparatus, fans, motors, heaters, ducts, flues, pipes, radiators, registers, plumbing fixtures and pipes, engines, generators, conduits, panel boards, electric outlets, refrigerating machines, elevators, and every detail of apparatus and equipment. The engineer must adapt his plans for the equipment of the building to suit the available space, the arrangement of the rooms and the esthetic requirements of the building. This naturally involves much patience, study, time and expense on the part of both architect and engineer. Satisfactory results in the plans of both the architect and engineer can result only from a mutual, helpful "give and take" policy. It must be granted that the engineer's responsibility does not wholly relieve the architect from responsibility for seeing that the building and its equipment shall properly come together during the period of construction and be complete at the conclusion of the work.

To a large extent the architect must serve as administrator in co-relating the architectural and engineering plans and specifications, in preparing contracts, in passing on extra items, allowances and payments (after the engineer has checked and approved same) and in every way serving as the centralizing agency for all of the details of the work.

THE FUNCTIONS OF THE ENGINEER.

The engineer should give special attention to a study of the character and purpose of the building. He should prepare a preliminary scheme which should serve as a basis of discussion with the architect and, when desired, with the owner, so that the nature and extent of the equipment may be determined during the early stages of the preparation of the plans. He should be capable of advising in an expert manner on all the problems and details of this equipment. He should be familiar with the cost of materials which is necessary that extravagance be avoided.

The engineer should then prepare the working and detail drawings, with specifications, which involve calculations for all parts and the determination of sizes, the selection of each piece of apparatus and the co-relation of each portion of the equipment to all other portions, and to the building. He should be available to architect and owner for consultations and advice on all matters pertaining to the work, should give all necessary information and instruction to contractors during the bidding and the installation of the work, and in a thorough manner supervise the complete installation, including the giving of all expert inspection of materials and labor. He should make all the necessary tests and report on same to the architect and owner. Knowledge of the value of materials and labor is essential also that he may examine and report upon requests for payments and on extra charges or allowances.

It is the engineer's special province to see that all the requirements of the specifications and contract are met and that an equipment complete in every respect is turned over to the owner. The engineer should also give supervisory care of the operation of the plant for a reasonable term after the completion of the installation, this period to cover that usually required for making necessary adjustments and for familiarizing the owner's employees with the equipment.

CO-OPERATION OF THE ARCHITECT AND THE ENGINEER.

The active co-operation of the architect and engineer is essential to a well designed and properly equipped building.

Lack of such cooperation is bound to result in confusion, overlapping or omissions which will prove embarrassing to the architect and engineer, all of which is needless. On the part of the architect there should be a readiness to meet any reasonable requirements of the engineer for spaces which are essential to an efficient plant. On the other hand the engineer should stand ready to so arrange the equipment as not to mar the character of the building or any of the rooms therein. The engineer should also be prepared to design special equipment to meet special conditions so far as these special conditions do not limit or cripple the efficiency of the equipment.

There are cases in which units of the equipment have caused a hideous appearance in a building just as there are cases in which the insistance of the architect for placing of radiators, registers or other details of the equipment in certain locations have brought about disastrous failures of the equipment, especially of the heating and ventilating plant. While the location of radiators, registers, pipes and other details of a plant are capable of considerable latitude there are certain requirements from which deviation cannot be made without inviting disaster. Especially is this so in the case of a ventilating system, in which the diffusion of the air is most important. An architect in preventing the proper distribution or placing of the units of heating and ventilation system thereby limits the efficiency of the heating and ventilating system.

The engineer should co-operate with the architect in the selection of bidders, in the preparation of contracts and in the issuance of extra orders and certificates of payment. The engineer should supervise the installation of the work placed in his charge but the intimate relations of the building and its equipment demand co-operative supervision of the architect and engineer at those points where the architectural and engineering work tie together.

LOSS OR GAIN IN THE EMPLOYMENT OF THE ENGINEER.

It has always seemed to me that the architect loses his position of dignity and independence if he submits to the use of contractor's or manufacturer's plans. Certainly he lacks that independence of action which is his when employing independent engineers. Especially is this so in passing judgment upon materials and amount of extra orders or allowances. If the contractor or manufacturer who made the plans and specification for the job is the contractor installing the work there is bound to be a feeling of leniency on the part of an appreciative architect, and if the contractor installing the work is other than the contractor making the plans and specifications there is a natural hesitation in asking for additional advice from the maker of the plans and specifications. Also it is a fact that one contractor will rarely make a decision adverse to the interests of another.

If an error is found during or after the installation of a plant designed by a contractor, the cost of remedying the mistake falls upon the architect, for the contractor installing the work, especially if he be not the author of the plans, will not assume the expense of correcting the error, and there could be nothing more ungracious than to ask the contractor who made the plans and specifications gratis, or practically so, and failed to secure the contract, to remedy the mistake.

The architect, in employing independent consulting engineers, gains a very material moral advantage, because the client appreciates that he has secured expert advice in the best way. He has entire independence of action in passing on materials, workmanship, cost of extras and amount of allowances.

The employment of independent engineering services results in the installation of the best plant, at the least cost, and one in which there will be a minimum cost for operation and maintenance. This is the natural result of the selection of material by the engineer free of commercial interest.

The injustice which ensues when one contractor is obliged to bid upon work, the plans for which are prepared by another, is eliminated. Similarly the disadvantages due to the wide variance of contractors' competitive plans are eliminated.

The very real risks incurred when bids are taken upon incomplete plans and specifications are avoided.

Competition inevitably obtains the best results when all contractors bid upon the

same plans prepared by engineers independent of any contracting or manufacturing interests.

The best workmanship is assured because the acceptance of all work and material of the contractor depends upon the approval of disinterested and specially trained experts.

The services of the engineer are of much the same nature, and possess much the same advantages in connection with engineering work as do the services of the architect in connection with the structural and architectural details of the building. Engineering problems require the services of the specially-trained and qualified engineer.

The best results are obtained when the engineer and architect are associated from the earliest stages of the work, thus making possible proper provisions for the installation of the plant and its ramifications, and so avoiding the necessity, which otherwise frequently occurs, of materially altering the plans, or of cramping the plant into a too limited space to its permanent injury. Such a course best harmonizes the various elements of the building and its mechanical equipment.

The concluding portion of Mr. Kimball's paper, which will be published in the April issue, considers, among other things, the relation of the engineer to the matter of separate contracts; also the question of engineers' fees and payments.

The Experimental Plant of the New York State Commission on Ventilation

In view of the comprehensive character of the experiments conducted during the past year by the New York State Commission on Ventilation, considerable interest attaches to its experimental plant which is so arranged that almost any desired air condition can be obtained. The accompanying description of the plant, as well as a detailed report of the experiments conducted, was contained in a paper by D. D. Kimball, member of the commission, and George T. Palmer, chief of the investigating staff, which was presented at the recent annual meeting of the American Society of Heating and Ventilating Engineers.

To give an idea of the scope of the investigation which was made possible by the arrangement of the plant, it may be stated that in the principal experiment conducted, the efficiency in mental work of four subjects, young men about 18 years old, students of the College of the City of New York, was compared in five different atmospheric environments, as follows:

68° F., 50% relative humidity, ample air supply (about 45 cu. ft. per minute per person).

68° F., 50% relative humidity, no air supply (a stagnant condition).

86° F., 80% relative humidity, ample air supply (about 45 cu. ft. per minute per person).

86° F., 80% relative humidity, no air supply (a stagnant condition).

86° F., 80% relative humidity, no air supply (a stagnant condition, but with the presence of small electric fans blowing air on the faces of the subjects).

This experiment was thus planned to give information on the subjects' efficiency in (1) a hot, moist room as compared with a cool room; (2) a room with ample supply of fresh outdoor air as compared with a room in which no air at all was supplied; and (3) a hot, moist room where relief was afforded by the moving air from electric fans.

The detailed results of these and other tests are given at length in the report, as noted in the February issue.

The experimental plant is installed in the Biological Laboratories of the College of the City of New York, at 139th Street and St. Nicholas Avenue, New York, where it occupies two rooms. It was aimed to make possible the maintenance of the same or different atmospheric conditions in the two rooms, with temperatures varying from that existing out of doors or less up to 100° F. in

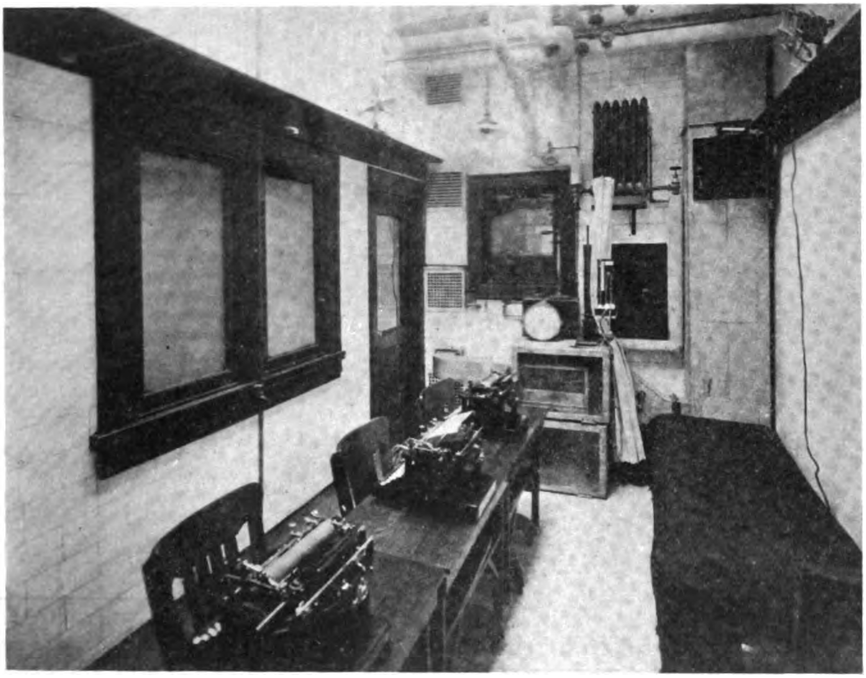
zero weather, with humidities varying from the saturation point to practically nothing.

Later a cooling system was added to the plant, the cooling of the observation room being accomplished by cooling the water in the air washer and by the use of direct expansion coils on the walls of the observation room.

The conditions in the observation room are under the control of the observers in the control room. They may be manually or automatically maintained.

washer the air for both rooms passed through common channels.

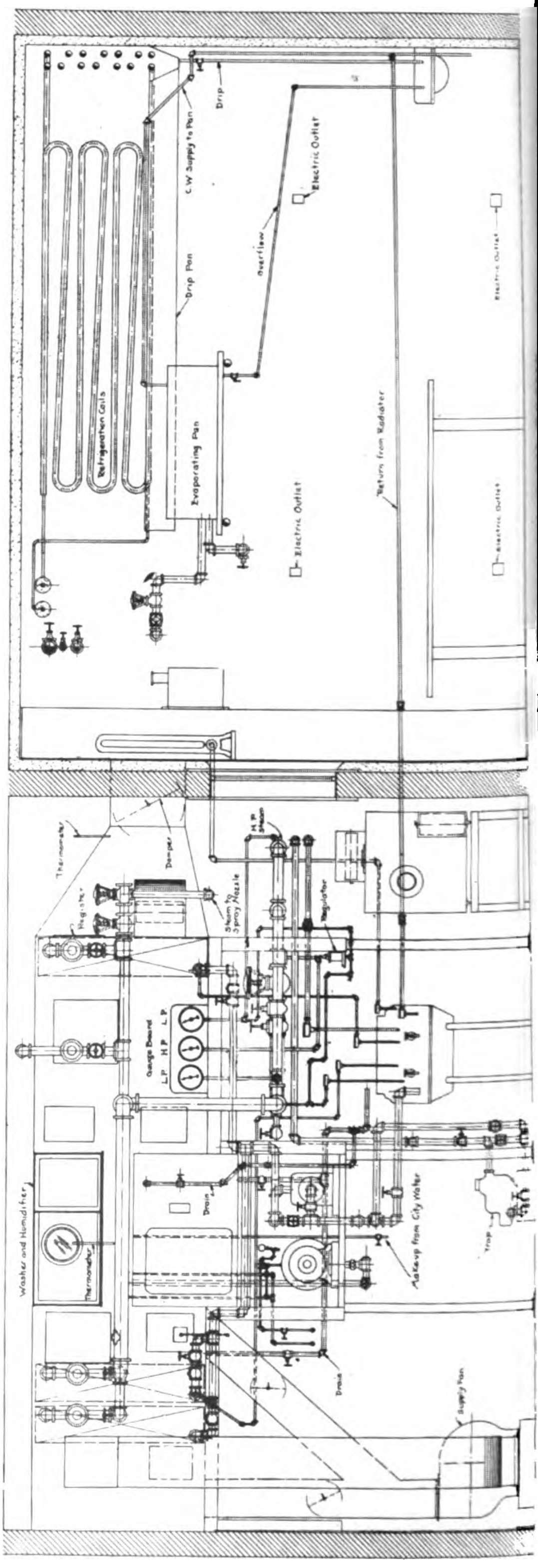
From this point the apparatus is divided into two parts, one for each room. Each part consists of a chamber in which the air from the dryer and washer may be mixed, from which the air passes through reheaters and thence to the rooms. In the observation room this air enters a 12 by 18 in. vertical duct the height of the rooms, having four 12 by 12 in. openings so that the air may enter the room at any one of four levels.



OBSERVATION ROOM IN EXPERIMENTAL PLANT OF NEW YORK STATE COMMISSION ON VENTILATION.

The air is taken in through a ventilator on the roof and drops to the fresh air fan setting on the floor. The discharge from this fan has two branches, one of which enters the plenum chamber before the tempering coil while the other branch enters beyond the tempering coil. Thus the air may be passed through or by these coils to the air washer or dryer. Over the face of the tempering heater there has been placed a louvred damper so that the heating effect of the heater may be obsolutely and immediately eliminated. To the discharge side of the

A similar vertical exhaust duct is placed in the apparatus room with four openings from the observation room and one from the apparatus room. From this duct the air is drawn by the exhaust fan, by which it may be discharged into the attic space above the ceiling or back to the fresh air fan for recirculation, if desired. Dampers are provided for regulating the flow and volume of the air. Special openings, 1 in. in diameter, with tight fitting covers, are placed at convenient points for air measuring and sampling.



The fans were furnished by the Massachusetts Fan Co. and are of the squirrel cage, or multivane, type, being different only in the direction of discharge, otherwise the same description applies to both fans.

The fresh air supply is a No. 1 top vertical discharge fan with outlet 8 in. x 9 in. The exhaust fan is the same size, but is a top horizontal discharge fan, with outlet 8 in. x 9 in.

The runners are 12 in. in diameter by 6 in. in width, the width being uniform. The fans being of the multivane type, the blades are pitched forward in the direction of rotation, as the action of these fans depends upon the kinetic energy rather than upon the centrifugal force, building up a pressure within the housing. The inlets are large compared to the diameter of the wheel, being 9¾ in. at the upper base of the frustrated cone, while the diameter of the lower base is 13 in.

The mechanical efficiency of the fans, when operating at 25% restriction from free discharge, under laboratory tests, is 54%.

The motors, which were manufactured by the Diehl Mfg. Co., are designed to operate these fans at 850 r.p.m. and are equipped with speed regulators, by means of which the speed may be reduced 50% through armature resistance.

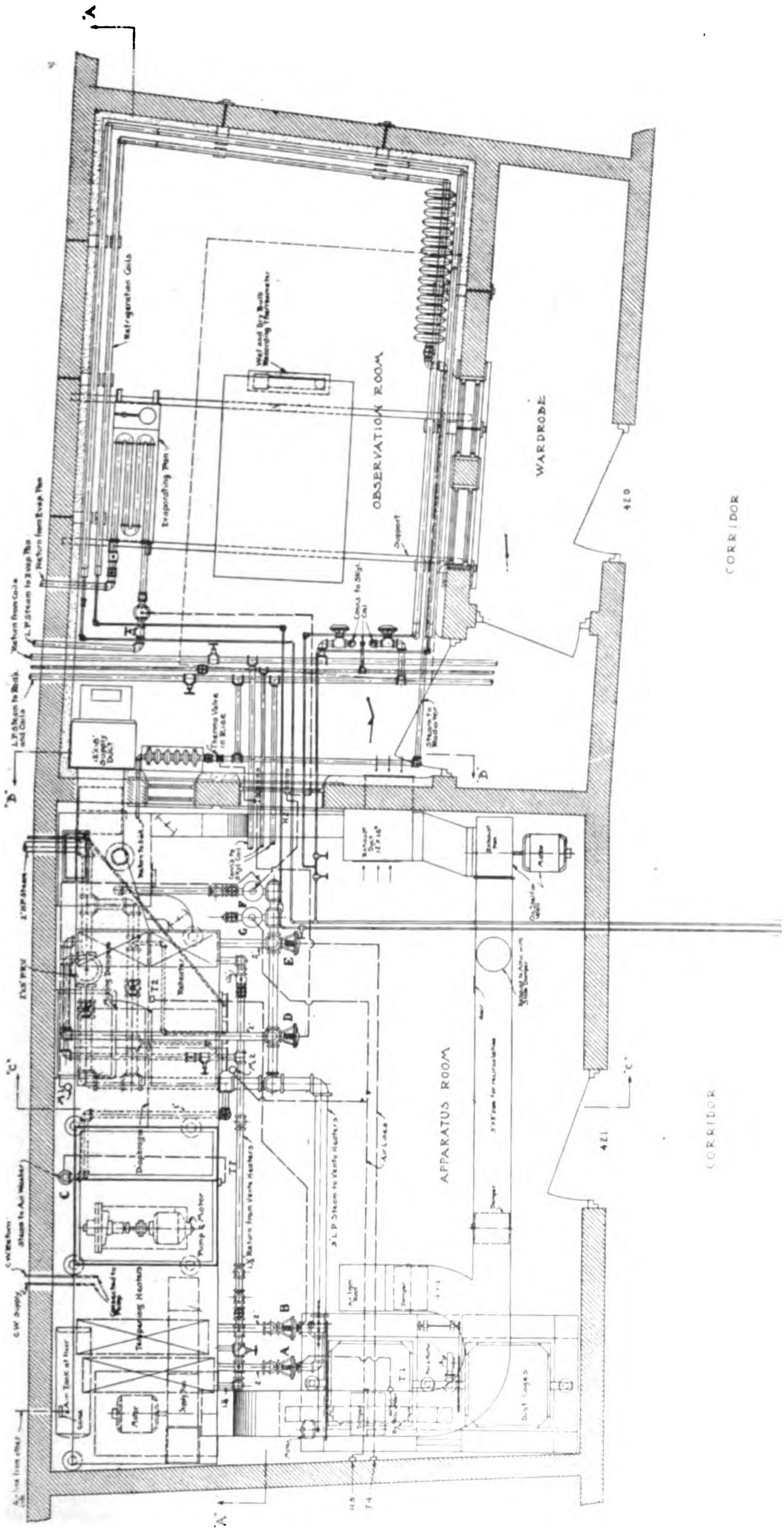
Each motor is a ½ h. p., 230 volt, shunt wound, type G, frame No. 302, and is direct connected to the fan.

The tempering heater consists of two rows of 40 in. regular Vento heater sections, each row six sections wide, sections 5⅜ in. center to center. This heater is common to the work of both rooms.

The two reheaters, there being a separate reheater for each room, each consists of one row of 40 in. regular Vento heaters as above, six sections wide, 5⅜ in. center to center.

The air washer was specially made for this work by the Warren Webster Co., and is 36 in. long, 15 in. high and 36 in. wide, with a water tank 8 in. deep under the washer.

The circulation pump is of the rotary type with cast iron casings and bronze impelled, driven by direct-connected Crocker-Wheeler, direct current 230-volt, shunt-wound, electric motor of ½ h. p.

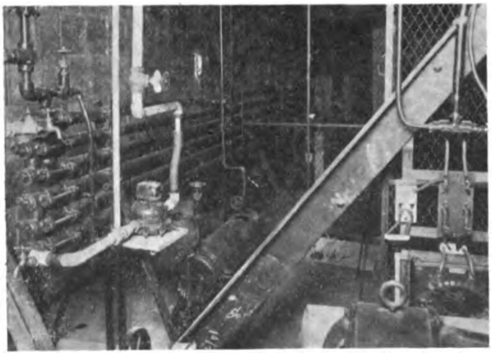


PLAN OF APPARATUS AND OBSERVATION ROOMS OF NEW YORK STATE COMMISSION ON VENTILATION.

Under the washer is a drying tank to be used for drying the air for securing dry air in the observation room when desired. It consists of a galvanized iron box, 36 in. long, 36 in. wide, and 24 in. deep, containing four shelves, each in two sections, covering the entire area of the box, these shelves consisting of 1/8 in. mesh No. 16 galvanized iron wire screen, edges of same bound over 1/4 in. galvanized wire, shelves supported on angle and tee irons. It was proposed to dry the air by the use of calcium chloride placed upon the shelves. A 1 in. drain from this tank to sink below is to be provided as shown. The use of this device has not proved practicable with volumes of air used to date.

The above described apparatus is capable of delivering 800 cu. ft. of air per minute maximum, with provision for reducing the amount of air to 60 cu. ft. or 30 cu. ft. per minute minimum for each room.

Steam is supplied to the apparatus from a high pressure line brought up from the basement from the Biological



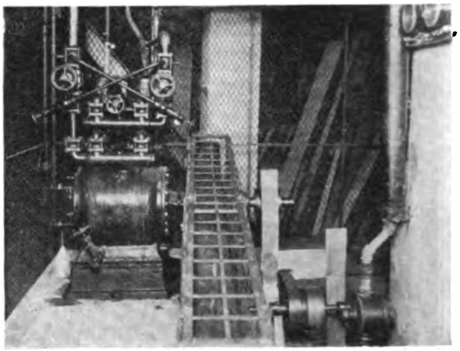
ARTIFICIAL COOLING APPARATUS, SHOWING AMMONIA CONDENSING COILS, WATER METER AND AMMONIA RECEIVER.

Laboratories through a 2 in. pipe, the steam passing through a 2 by 3 in. Victor pressure reducing valve into a 3 in. pipe with 2 in. supply connection to each section of the heater and a 1 in. connection to the water heater in the tank of the air washer. One-half inch connections are also made to each of the air discharge ducts for use in humidifying experiments if desired. From each heater a 1¼ in. return pipe is connected into a 1½ in. return main, discharging through an Anderson trap either into the return of the heating system of the building or into the sink.

All steam and return pipes and fittings and the ducts are covered with H. W. Johns-Manville Co.'s 85% magnesia sectional covering.

ARRANGEMENT OF AUTOMATIC HEAT AND HUMIDITY CONTROL APPARATUS.

The automatic temperature and humidity controlling system was manufactured and installed by the Standard Regulator



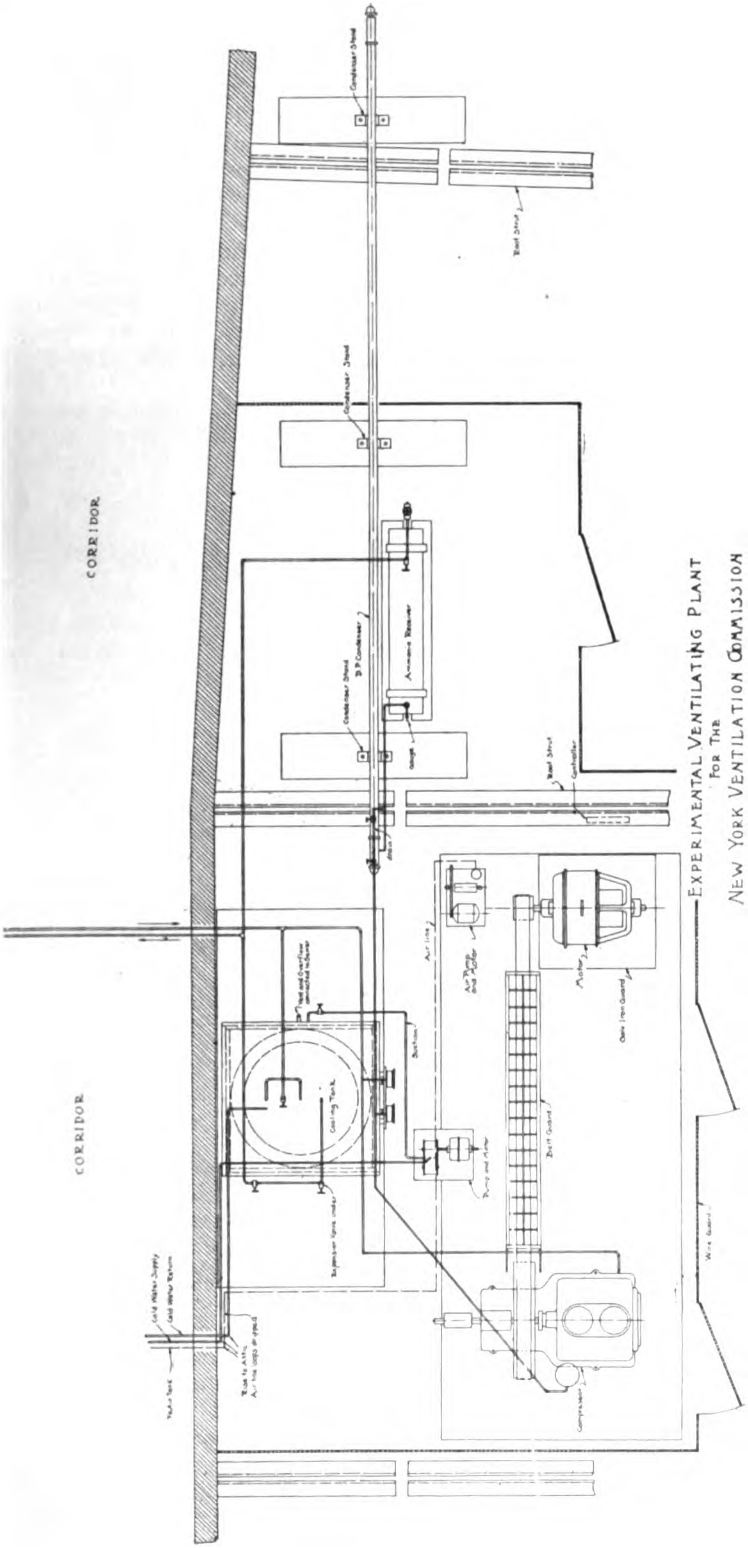
AMMONIA COMPRESSOR, ROTARY PUMP AND COLD WATER TANK FOR REFRIGERATING PLANT.

Company. This installation originally included a small hydraulic air compressor which was later replaced with an electric compressor. The aim is to provide and maintain automatically any temperature and humidity desired in either room within 1° in temperature and 2% in relative humidity.

The temperature of the incoming air passing through the primary and reheating coils is controlled primarily by thermostat "T-1," located in the intake duct, secondarily by thermostat "T-2," located in the space between the heater and air washer, and finally by thermostats "T-3" and "T-4," located in the observation and control rooms.

Thermostat "T-1" controls diaphragm valve "A" on the outside section of the tempering coil, and is adjusted to open the valve when the incoming air is at or below 35°. It is intended that at no time shall the inner section of the coil or air washer be exposed to freezing temperatures.

Thermostat "T-2" controls diaphragm valve "B" on the inner section of the



PLAN OF REFRIGERATING SYSTEM, EXPERIMENTAL PLANT OF THE NEW YORK STATE VENTILATION COMMISSION.

tempering coil. Its function is to control the temperature of the air entering the air washer and is adjustable to any predetermined degree.

Thermostat "T-3" is located in the observation room and controls diaphragm valve "D" on that part of the reheater coil supplying heat to the room. It also controls the diaphragm valves on the direct radiators located in that room. This thermostat has an extended thermostatic member projecting into the room, with the adjustment so arranged that it may be operated from the control room.

Means of creating and controlling humidity is provided in two ways, the first being to condense steam directly in the air washer water, thereby supplying sufficient heat to the water to permit a rapid absorption of moisture by the air passing through the air washer. The heat supplied to the water is controlled by thermostat "T-7," which has its thermostatic member submerged in the settling tank. This thermostat controls diaphragm valve "C" on the steam supply to the water heater. As the temperature of the air entering the washer is held uniform by thermostat "T-2" and the temperature of the washer water is held uniform by thermostat "T-7," the relative humidity of the air leaving the washer is held constant. The relative humidity may be increased by raising the adjustment of thermostat "T-7" or raising the adjustment of "T-2."

OBSERVATION ROOM OCCUPIED. EXPERIMENTAL PLANT, NEW YORK STATE COMMISSION ON VENTILATION.

Thermostat "T-4" is located in the control room and operates diaphragm valve "E" in that part of the reheater supplying heat to this room, also the direct radiators located in the room.

The temperature of the space between the inner and outer skylights in each of the rooms is controlled by thermostats "T-5" and "T-6," located in the mentioned space, which thermostats operate diaphragm valves on the skylight coils. The adjustment of these thermostats can be operated from the floor by means of chain pulls.

A second means of creating humidity was provided for by discharging steam through a nozzle directly into the air after it leaves the reheater coils. The control for this scheme was obtained by the use of hygrostat "H-2" located in the

observation room and "H-3" located in the control room. Hygrostat "H-2" controls diaphragm valve "F" on the steam supply to the nozzle in the duct supplying air to the observation room. Hygrostat "H-3" is located in the control room and controls diaphragm valve "G" on the steam supply to the nozzle for the air supply to that room.

The use of the steam nozzles not proving satisfactory, an evaporating pan with submerged coil was installed in the observation room, the operation of this coil being controlled by hygrostat "H-2."

Hygrostat "H-2" has its thermostatic members projecting into the observation room, with the mechanism arranged so that it may be adjusted from the control room.

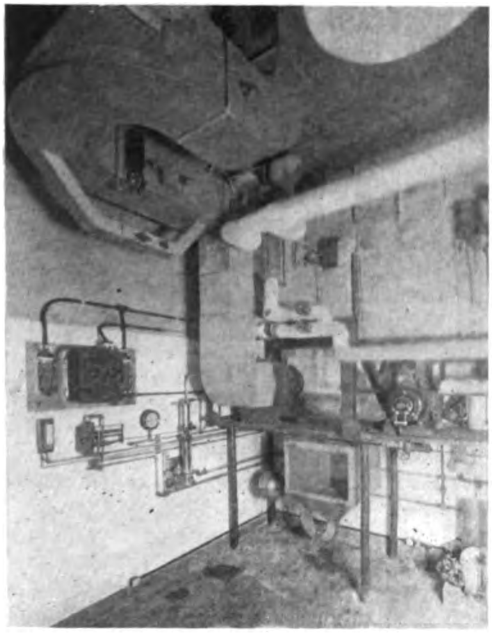
Hygrostat "H-2" was intended to be employed to operate lever motor "M-1," and hygrostat "H-3" to operate lever motor "M-2," for the control of the amount of air to be passed through the dryer.

The motive power for the thermostats and hygrostats is pneumatic pressure originally generated by a 2½ by 3 by 6 in. hydraulic air compressor of one cubic foot of free air per minute capacity. This was later replaced by an electrically operated compressor.

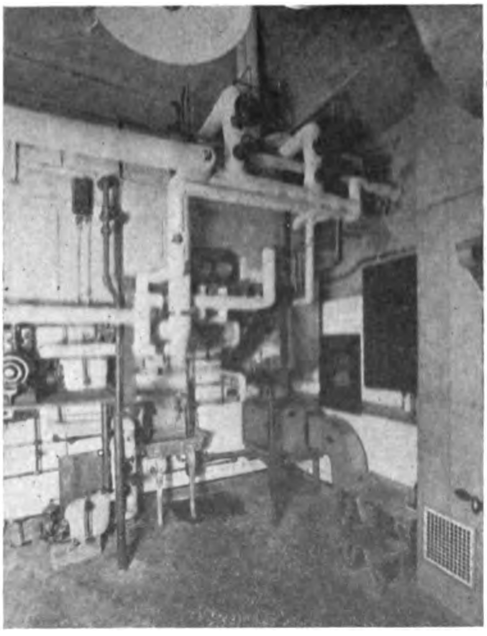
Each fresh air and vent or exhaust opening is provided with an air equalizing register, these registers being equipped with adjustable louvres, key operated.

Three animal cages were constructed, each 36 in. long, 24 in. wide and 16 in. high of No. 20 galvanized iron, all joints being soldered, with removable door in front, full size of front of box, the door being glazed with tight fitting wired glass provided with rubber packing against which the door fits tightly. Later two revolving glass cages with stationary wire cages therein were constructed. These cages are used in animal studies, principally on dust. These boxes were all provided with fresh air and exhaust connections.

The cooling plant, which was later installed, was furnished by the Brunswick Refrigerating Co., and included a single acting compressor of four tons refrigerating capacity. The compressor is of the belt-driven, two-cylinder, single-acting,



CORNER OF CONTROL ROOM, SHOWING INLET DUCT FROM ROOF OF BUILDING, SUCTION FAN, ENCLOSED PRIMARY HEATERS, AIR WASHER, ETC.



ANOTHER VIEW IN CONTROL ROOM, SHOWING AIR WASHER, SPACE IN WHICH REHEATERS ARE PLACED, EXHAUST DUCT FROM OBSERVATION ROOM, AND CENTRIFUGAL PUMP TO AIR WASHER SPRAYS.

enclosed self-oiling eccentric drive type, provided with self-acting head pressure relief valve and by-pass between suction and discharge sides. Each cylinder is 4⅞ by 4⅜ in.

The condenser for liquefying the ammonia is of the inner tube type, 19 ft. long by 6 pipes high and made of 1¼ in. and 2 in. special ammonia pipe.

The liquid ammonia receiver is 48 in. long by 10 in. diameter, with gauge glass, draw-cocks, inlet and outlet valves, and connections required.

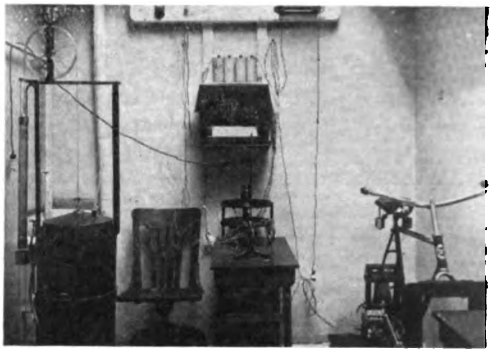
The oil interceptor is 36 in. long and 6 in. diameter.

A full set of 4½ in. gauges are mounted on a cast-iron gauge board.

The usual scale traps, valves, cocks, ammonia pipe, fittings, etc., to connect up the above are provided.

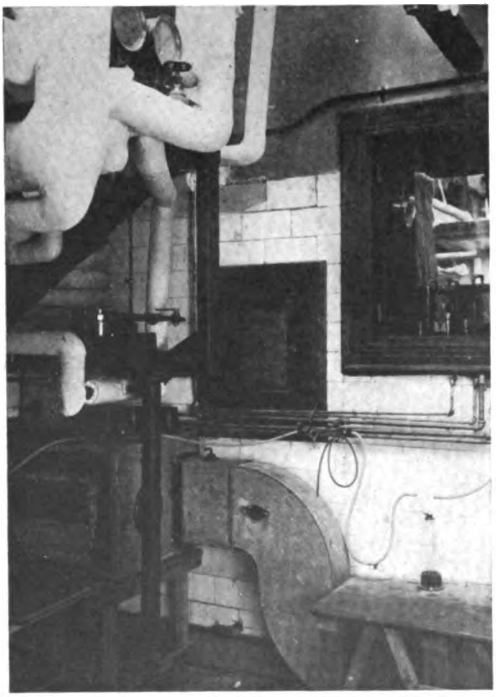
The motor is a 7½ h. p., 230 volt, D. C., 650 r. p. m. electric motor of Westinghouse make with rails, sliding base, pulley, starter and 5 in. belt for transmitting the power from the motor to the compressor.

The water cooling tank is 6 ft. high by 2 ft. 6 in. in diameter. This tank is made of 3/16 in. tank steel. Its insulation consists of granulated cork, waterproof insulating paper, and ⅞ in. boards.



APPARATUS USED IN PHYSIOLOGICAL EXPERIMENTS.

1. Spirometer.
2. Continuous Body Temperature Recorder.
3. Bicycle Ergometer.



PART OF CONTROL ROOM ADJACENT TO OBSERVATION ROOM.

Showing Windows Leading to Observation Room, with Thermostats and Humidostats.

The water is cooled by means of about 200 lin. ft. of 1¼ in. continuous electric welded wrought-iron direct expansion ammonia pipe.

The water circulating pump has a capacity of 5 gal. per minute and is of the rotary type. An extra pulley is placed on the extended compressor shaft and a 2 in. wide belt is provided for transmitting power from compressor shaft to pump.

The water tank is capable of cooling 75 gal. of water per hour through a range of 40° F.

The cooling of the observation room may be accomplished by the use of cooled water in the washer, or directly, as is necessary when stagnant conditions are desired, by the use of the 300 lin. ft. of 1¼ in. direct expansion ammonia pipe made up into coils to suit the wall space conditions. These coils are so arranged that, if desired, only one-half the total need be used, but with all the coils in operation, and the compression side working only on these coils a temperature of approximately 50° F. can be produced in the observation room, when five persons are at work therein, with five 40-watt lamps and a 1 h. p. motor in operation, and with an outside temperature of close to 90° F.

The ammonia piping is covered with 2 in. of sectional molded cork pipe covering.

The Recirculating of Air in a School in Minneapolis

BY FREDERICK BASS.

(Presented at the annual meeting of The American Society of Heating and Ventilating Engineers, New York, January 20-22, 1915.)

The experiments to be described below were conducted in the same school buildings of Minneapolis, the Jackson and the Adams, in which similar experiments were conducted the year before and which were described in Vol. 19, transactions of this society on pages 328-350.* The period covered by the experiments was approximately four months.

The experiments this year were carried on in co-operation with the New York State Commission on Ventilation, and the funds were provided from a gift made to that Commission by Mrs. Elizabeth Milbank Anderson through the New York Association for Improving the Condition of the Poor.

One room in each of the school buildings named was selected for experiment. In each room the pupils were of the same grade and about nine years of age. The room in which the air was recirculated had an average attendance of 39.5, and the average quantity of air furnished per pupil was 8.9 cu. ft. per minute. The air was introduced at each desk top through funnel-shaped orifices and also through openings in pipes running along the top of the black boards at the end of the room. Air was exhausted at the ceiling through fifteen 3-in. orifices, evenly spaced. The air exhausted from the room was for the greater part of the time passed through a Warren Webster air washer, cooled about 15° F. and returned to the room.

In the Adams School the usual system of plenum fan ventilation was used. The average attendance in this room was 41 and the amount of air furnished per pupil was 35.4 cu. ft. per minute. The air was delivered by the fan supplying the whole building, was from the outside and received no treatment except that of being heated.

RECORD OF ROOM CONDITIONS.

Temperature records were kept by recording thermometers attached to inside walls about 7 ft. above the floor. The temperature of the air in the room was also ascertained at ten different points, five evenly spaced at the floor level and five at the height of about 4 ft. above the floor. The temperature of the incoming and outgoing air was also ascertained. Average temperature at inlet 56.0°; average temperature at outlet 70.4° F.

The relative humidity of the air was determined by use of hygrodeiks which had been compared with a sling psychrometer.

The carbon dioxide contents of the air of the rooms were determined by the use of a Petterson-Palmquist apparatus.

Dust counts were made by means of filtering 3 cu. ft. through 25 grams of resorcin. The average results are shown in Table 1.

TABLE 1—AVERAGE CONDITIONS OF ROOMS.

	Temp. Deg. F.	Relative Humidity P. Ct.	CO_2 p.p. 10,000	Dust Count
Adams (control)..	67.2	42.2	9.1	225,000
Jackson (experimental.	65.3	46.3	12.5	105,000

Outside temperature, humidity, precipitation, direction and velocity of the wind, were also recorded.

It was impossible to keep the windows closed at all times, and as it was not practical to keep an observer at the school throughout each day the periods in which the windows were opened were not at all times determined, although it is certain that windows were closed in the experimental room in the Jackson School, except for very short periods in the later days.

PHYSIOLOGICAL EXAMINATION OF PUPILS.

It was found necessary to get the written consent of the parents of all the pupils before the school board would allow the work to begin. The consent of the majority of the parents was obtained with

*Also published in The Heating and Ventilating Magazine for August, 1914.

some difficulty. At the beginning of the experiment, at the end and at a number of times during the experiment the children were all examined by a physician. They were examined for physical defects at first. Blood pressure was determined in two positions, but the technique followed by the physician was not such as to give the best results. Records of attendance, of progress in height, weight and chest measurements were also observed. Table No. 2 shows the result of the examinations.

TABLE 2—GAIN IN MEASUREMENTS OF PUPILS AND ATTENDANCE.

	Chest Inches	Height Inches	Weight Pounds	P. Ct. of Absences
Adams ..	0.14	0.409	1.28	5.3
Jackson .	0.58	0.298	0.75	4.1

At the time when the consent of the parents to the examination of the children was obtained, careful examination of the home environment of each child was estimated. They are classified in Table No. 3.

TABLE 3—HOME CONDITIONS.

	Good	Fair	Poor
Adams	12	3	3
Jackson	8	3	7

The children of the control group not only lived in better houses, but they were reported by the physician as giving evidence of better care, their teeth being in better condition, their bodies cleaner, etc.

PSYCHOLOGICAL TESTS.

Four psychological tests were given, a division test, a substitution test and two cancellation tests. The results from these tests have been plotted and are shown on Plates 1-4, inclusive.

CONCLUSION.

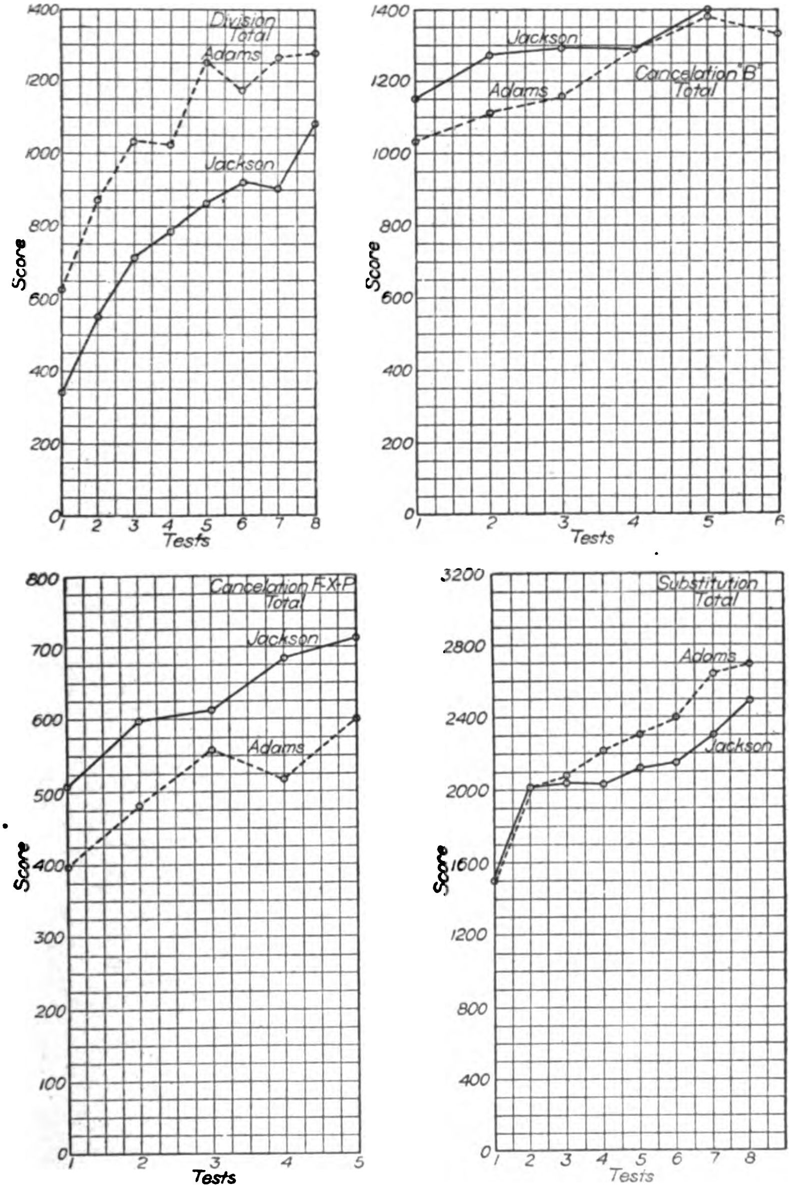
An examination of the conditions in the rooms indicates that the temperature in the experimental room was 1.9° lower than in the control room. It was also noticed that the temperature at the floor level averaged only 2.4° lower than that 4 ft. above the floor. This seems to indicate that upward ventilation does not leave the floor undesirably cold. Numerous examinations of air currents below the level of the currents on the desks showed that the air was continually in motion. The relative humidity of the two rooms differed by 4.1%. The carbon dioxide of the experimental school was, as might be expected, considerably higher than that of the control. The dust count in the control school was, as might be expected, greater than that in the experimental school where air washing was used. The experimental group gained less in height but increased more in chest measure. The absences due to sickness were greater in the control than in the experimental group, the difference not being very great in any of these particulars.

In the division test the experimental group showed a lower standard of accomplishment, but at the same time greater absolute progress and consequently considerable greater relative progress than the control group. In the substitution test a higher standard was again indicated for the control group, but the progress of each group was about the same. In the cancellation "B" test the control group overtook the experimental group, but the rate of progress was not very considerably greater. In the cancellation "F-X-P" the experimental group made a greater rate of progress than the control group.

In the psychological tests the classes "broke even" on the cancellation tests, and in the division and substitution the initial superiority of the control group is sustained throughout, but the progress made by the control group is not greater than that made by the experimental group.

The pupils in neither room were greatly disturbed by the tests, but the teachers did seem restive. Under the conditions in the experimental schoolroom it was not possible to remove the odors from the air at all times, and the odor at times was objected to by persons entering the room, although they would quickly become accustomed to it and feel comfortable. The teacher in this room said that she felt comfortable, but that other teachers coming into the room noticed the odor in the air and it annoyed her to be reminded that she was teaching in a room where so-called "fresh air" was not being supplied. The carbon dioxide determinations indicated that in spite of the recirculation of the air a large amount of leakage occurred. The character of the pupils themselves was in some instances such that the odors might naturally be expected to be difficult of removal.

These experiments were, as has already been said, conducted during a period of four months, but with all of the close observation that was given it is impossible to demonstrate physical or mental deterioration due to the use of recirculated



PLATES 1-4—RESULTS OF PSYCHOLOGICAL TESTS IN ADAMS AND JACKSON SCHOOLS, MINNEAPOLIS.

air. Neither is it possible to ascribe any discomfort on the part of pupils or the teacher to this recirculated air. The air washing was not in itself sufficient to remove all odors so that they could not be noticed by persons at the time of entering the room, but it was sufficient to remove them to such an extent that they were not offensive to persons occupying the room continuously. It would seem that if some method of removing the slight odor could have been utilized that recirculation of air would have been acceptable from every standpoint.

Still further experiments along this line might be undertaken to great advantage,

provided the control of conditions and the character of the observations would be more perfect than in the experiments described, but enough has been done here to show that any deleterious effect of recirculated air upon the occupants of a room during a four months' period is extremely difficult of detection, if, indeed, it exists at all.

(For discussion of this paper see report of annual meeting of heating engineers' society, in last issue.)

An Analysis of Modern Ventilation Theories.

By J. M. W. Kitchen, M. D.

It is a comforting matter for the ventilating doctor to have a good theory on which to base his practice, as well as for the medical doctor to have a sound scientific theory on which to found his efforts for the prevention and cure of abnormal conditions. The present movement attributing the evils of poor ventilation to superheat, humidity and air stagnation alone, reminds one of the poor-fit theories that have been adopted so frequently in past times by the medical profession to bolster their more or less successful practice.

There is no question as to the influence of heat, humidity and air stagnation as being in part, at least, the cause of the evil influences of poor ventilation, but it is not clear that deficiency in oxygen content and the presence of bacteria and volatile organic toxic matters are not also causative.

DISEASES MAY BE DUE TO MANY CAUSES.

Up to the present moment we note that various writers ascribe to single specific causes the incidents of rheumatism, cancer and other conditions. As causative of the former trouble, we have had attributed lactic acid, uric acid, intestinal ptomaines, including indican, specific bacteria having selective affinity for the affected tissues, and other specific causes. Yet there is not the slightest reason to doubt that a multitude of causes may be at work inciting and keeping up rheumatic conditions, including poor heart action, following insufficient exercise, poor gastric digestion, too much protein in the food supply, chilling the bodily surface, straining of the affected parts, and defective action of the kidneys, lungs, skin and intestines. More or less of these influences take part in causing so-called rheumatism in its various forms.

All the causative influences that have been suggested as causing the evils of poor ventilation may be at fault; and probably are usually at work in causing ill effects to health. Those which are immediately obvious to perception include humidity and heat; but those which are more slowly perceptive in their effect are those which gradually depress vital activity. The mere presence of carbon dioxide in large percentages need not be considered as being particularly immediately deleterious, for the body is habituated to the presence of that influence; but the absence of oxygen has much to do with determining the sum total of bodily activity. This is clearly shown by the various effects of different atmospheric pressures.

VOLATILE ORGANIC MATTERS MAY BE IRRITATING, IF NOT POISONOUS.

There is considerable reason to believe that the presence of volatile organic poisons emanating from bodily activities may have both undesirable depressing, as well as irritating, influences. If the individual's own body suffers from auto-generated toxic matters originating in the alimentary tract and diffused through the body, why should not a fellow human being suffer from the effects of some of those same materials escaping from the body in the expired air and from the cutaneous surfaces? Volatilized alcohol and nicotine in the atmosphere breathed can unquestionably injuriously affect the body through their inhalation. I have discovered that the volatile emanations from bacterial action in the hides of dairy cattle are conveyed to milk by being breathed by cows; and

there is no more reason to doubt that such volatile substances may be toxic to some degree than there is to doubt that bacterial decompositions of proteids generate toxic poisons or that the fumes of burned tobacco are poisonous.

As a matter of fact, there is no living form of matter that canot be killed by the volatile fumes of tobacco, it being merely a question of degree and time of the exerted influence.

Susceptibility to influence varies in different individuals, and in the same individuals at different times. Persons who are habituated to the influences of bad air do not apparently show the effect of such influences while unhabituated persons would immediately show bad results. The world is still very ignorant and finds it difficult to connect ultimate effects with long distance and cumulative causation.

The capable engineer-doctor should protect his patrons from all evil influences which may have an ultimate evil effect, the ultimate evil depressive influences of defective supplies of oxygen, and non-aerial dilution of volatile excretory matters from the human body or from any other organic decompositions.

IMPORTANCE OF BEING GUIDED BY OUR SENSES.

The fact that we cannot mathematically weigh or otherwise compute these matters in foul air is no evidence that they do not exist. We must base our theory as to their nature and presence upon the results produced by their influence. We can smell and taste and feel influences as to which we have no other method of computation, and if anyone insists that these undefinable matters do not exist or are not deleterious, why is it that one feels immediately the influence of air surcharged with the respiration of many human beings, such as is experienced when one enters the subway cars and before any mere influence of heat or moisture on the body can be exercised? Even in heated and depressive atmospheric conditions, the depressing influence is probably due to the interference with quick transportative interchange of carbon dioxide and oxygen in the respiratory effort.

One may breathe very hot air without experiencing discomfort, if the air is pure, or very moist air, if the air is pure, for a considerable time without experiencing discomfort. One may be subject to great heat, as in a hot water bath, for a long time, if one is breathing pure air.

So long as the world is so ignorant as to unknown influences which affect our bodies for good or evil, we are not justified in coming to definite conclusions in regard to those possible, but not understood, influences; and this, it seems to me, should be applied in this matter of ventilation.

We should breathe clean, fresh air, having normal constituents as to its best proportions of oxygen to develop our best activities. Other things being equal, the more oxygen we have in the air we breathe, the stronger we are to accomplish the activities of life.

Compressed air means more oxygen to breathe. A diffused induced draft means oxygen diffusion. Hence a plenum draft induces more vital activity than the exhaust draft, and the person working at the sea level is capable of greater activities than the person working at higher levels. This is apparently due to the fact that every respiratory effort succeeds in utilizing a larger amount of oxygen. It is certain that various excretory volatile matters from the human body produce nausea, loss of appetite and other disturbances, and if that result is commonly to be observed, we have no right to say that there are not injurious matters in poor air other than heat, moisture and lack of movement.

Heat From Radiators Under Different Temperatures

By Charles A. Fuller.

The subject of the rate of transmission of heat from radiating surfaces under different temperatures is one of considerable importance when a room temperature other than 70° F. is to be maintained, or when high pressure steam is to be used. The transmission factor for cast-iron radiation generally used is 250 B. T. U. per square foot per hour and 300 B. T. U. per square foot for pipe coils and wall radiation. The required room temperature for nearly all classes of buildings is 70° F., with a few exceptions, such as factory buildings, foundries and store rooms which are frequently figured on a basis of 40° F. to 60° F., as the case may require. Dry rooms may be estimated at a temperature of from 90° F. to as high as 160° or 170°, depending upon the class of material handled.

For low pressure steam heating the average temperature of steam in the radiator is approximately 220° F. For convenience sake, we will designate the average temperatures dealt with, namely, room temperature 70° F. and steam temperature within the radiator 220° F., as "standard conditions." Under these conditions, the "standard temperature difference" would be 220—70=150° F. Assuming that the average cast-iron radiator gives off 250 B. T. U. per square foot, the rate of transmission would be 250÷150=1.67 B. T. U. per square foot per degree difference per hour.

TRANSMISSION FACTOR DOES NOT REMAIN CONSTANT FOR ALL TEMPERATURE DIFFERENCES.

It is generally assumed that this factor remains constant for all differences in temperature between the inside and outside of the radiator and the total transmission for other than the standard difference of 150° determined from this factor. To illustrate, assume that the same radiator as mentioned above is placed in a room the temperature of which is 100° F. instead of 70°. The difference in temperature between the steam and the room would be 220—100 =120°.

The usual method of procedure in determining the total heat given off from 1 sq. ft. of radiating surface under these conditions would be to multiply the temperature difference of 120° by the rate of transmission under standard conditions; namely: 1.67, giving a total transmission of 200 B. T. U. per square foot. We have no right to assume, however, that the factor of 1.67 remains constant for varying differences of temperature. Various tests which have been made indicate that it does vary directly with the change in temperature, that is, as the temperature difference increases, the rate of transmission increases.

The principal reason for this is undoubtedly due to the fact that as the difference in temperature between the inside and outside of the radiator increases, the air surrounding the radiator flows up over the surface at a higher velocity, which naturally increases the rate of transmission per degree difference.

COMPARISON OF VARIOUS TESTS AND TABLES.

In an attempt to establish some definite law for this variation the writer has taken the records of various tests and tables from several books and compared the results. The first table given below is taken from Allen's "Notes on Heating and Ventilation." The succeeding ones are from Carpenter's "Heating and Ventilating Buildings."

The first column in each of these tables gives the difference in temperature between the steam in the radiator and the room temperature in which the radiator is placed.

The second column gives the transmission factor, or transmission in B. T. U. per degree difference per hour. It will be noted that in each of these tables this factor increases as the temperature difference increases, for the reason as stated above.

The temperature difference of 150° is taken as the normal or standard con-

TABLE 1

Temperature difference.	B. t. u. per degree difference.	Percentage of variation per degree.
80	1.425	0.220
90	1.455	0.210
100	1.485	0.216
110	1.515	0.250
120	1.550	0.230
130	1.590	0.225
140	1.635	0.180
150	1.665	....
160	1.710	0.270
170	1.745	0.240
180	1.770	0.210
190	1.815	0.250

TABLE 2

Temperature difference.	B. t. u. per degree difference.	Percentage of variation per degree.
50	1.29	.213
60	1.33	.209
70	1.36	.212
80	1.40	.209
90	1.43	.213
100	1.47	.208
110	1.51	.198
120	1.54	.205
130	1.57	.180
140	1.61	.200
150	1.64	....
160	1.66	1.30
170	1.69	1.35
180	1.72	1.50
190	1.75	1.57
200	1.78	1.60

TABLE 3

Temperature difference.	B. t. u. per degree difference.	Percentage of variation per degree.
50	1.54	.206
60	1.58	.210
70	1.63	.199
80	1.67	.197
90	1.72	.189
100	1.76	.186
110	1.80	.180
120	1.84	.140
130	1.88	.160
140	1.91	.150
150	1.94	....
160	1.97	.160
170	2.02	.205
180	2.05	.193
190	2.09	.195
200	2.12	.186

dition. The writer then gives, in the third column, the variation of the transmission factor in percentage for each degree of variation from the standard.

To illustrate, take the factor of the temperature difference of 130° given in the first table. The factor for this difference is 1.59. The factor for standard conditions is 1.67. To find the percentage of variation: 1—(1.59÷1.665)=0.045 or 4.5%.

This is taken for 130° difference, which is 20° below the standard 150°. The variation is therefore 4.5% for 20° F., or 0.225% per degree. The percentages for the other differences are determined in the same manner and are recorded in the third column of each table.

It might be noted here that the important point in this particular investigation is not the rate of transmission for any particular radiator or heating surface, but a method of determining the variation of this rate under different conditions and thereby establishing some law or rule which will apply to all cases.

It will be noted from an examination of the three tables that the percentage of variation is nearly constant throughout the entire range. The average of all of the above results shows that the variation is approximately 0.2% per degree or 2% for each 10° above or below the standard difference. This would indicate that for all practical purposes it would be sufficiently accurate to assume 0.2% per degree as the variation in the transmission factor for all surfaces.

Having established this percentage of variation it is now possible to determine the total B. T. U. transmission for any radiator, coil or heating surface, for all steam and room temperatures. To illustrate the application of this, assume a pipe coil placed in a room which is to be heated to a temperature of 120° F., the steam temperature in the coil to be 230°F. What would be the B. T. U. transmission from the pipe coil per square foot?

The difference in temperature in this case is 230—120=110° F. Under the "standard" difference of 150° the coil would transmit 300 B. T. U. per square foot or 300÷150=2 B. T. U. per square foot per degree difference per hour. Under the assumed conditions, the difference is 150—110=40° F. below standard. From the conclusions arrived at, as stated above, that the factor decreases 0.2% per degree, the decrease would be 40x0.02 or 8%. 2×0.08=0.16, the amount of decrease in the factor.

2—0.16=1.84, the transmission factor under the assumed conditions.

1.84×110=202.4 B. T. U. per square foot given off from the coil.

This same method of procedure should be followed when the difference in temperature is above 150° with the exception that the amount of variation is added to the factor instead of subtracted, as above.

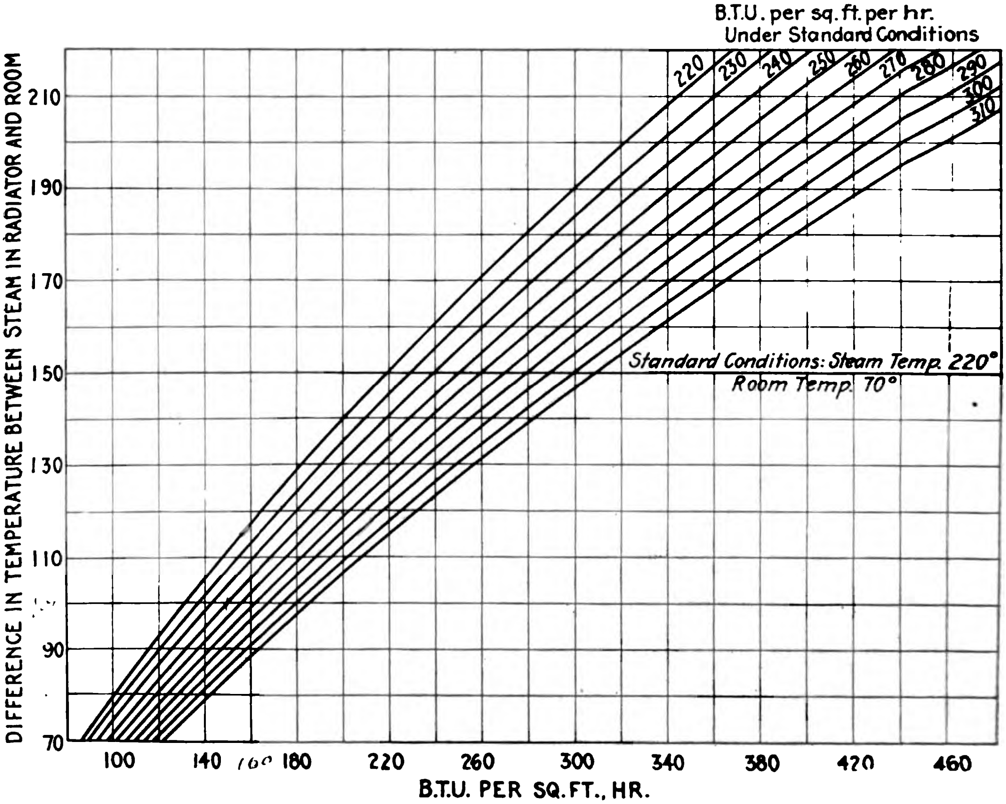
USE OF CHART FOR SIMPLIFYING CALCULATIONS

In order to eliminate the necessity of going through the computations for each specific case, the writer has plotted a set of curves, shown in the accompanying chart, which simplify the work. At the left hand side of the chart is given the difference in temperature between the steam in the radiator and the room temperature. The figures at the bottom of the chart indicate total B. T. U. transmission per square foot of heating surface per hour. The curves shown are for various types of radiators and radiating surfaces, and the figures by which these curves are designated, given at the upper right hand side of the chart, represent the B. T. U. transmission per square foot per hour under standard conditions. Pipe coils are estimated to transmit 300 B. T. U. per square foot, as previously stated, and therefore, if it is desired to determine the transmission under other than standard conditions, the 300 B. T. U. curve should be used.

Let the problem given above be solved by means of the curve. The steam temperature was 230° F. and the room temperature 120° F. or the difference was 110°. A pipe coil was used, therefore the 300 B. T. U. curve should be referred to.

At the left side of the chart find the point corresponding to 110° difference. From this point follow a line horizontally to the right until it intersects the 300 B. T. U. curve. From this point of intersection follow a line vertically to the bottom of the chart and the point is found to lie at the 202 B. T. U. point which checks with the results obtained above.

Another application of the curves would be in such cases where a building has been heated with high pressure steam and it is desired to change to ex-



HEAT TRANSMISSION FROM RADIATING SURFACES WITH VARYING DIFFERENCES IN TEMPERATURE BETWEEN STEAM IN RADIATOR AND ROOM.

haust or low pressure steam. The curves may be used to determine how much additional surface must be added.

Assume that a certain room has 200 sq. ft. of surface which has a transmission of 250 B. T. U. per square foot under standard conditions. The system is operating under a pressure of 40 lbs. per square inch and the amount of surface in this particular room is just sufficient to maintain a temperature of 70° F. in zero weather. How much additional surface must be added if the pressure is reduced to 2 lbs. and the temperature to be maintained as before?

Steam temperature corresponding to 40 lbs., 286.5° F., 286.5—70=216.5° F. difference.

The 216.5 line is found to intersect the 250 B. T. U. line at the 410 B. T. U. point. The radiator, therefore, gives off 410 B. T. U. per square foot.

200×410=82,000 B. T. U. necessary.

82,000÷250=328 sq. ft. necessary under new conditions.

328—200=128 sq. ft. that must be added. The accompanying table, taken from the writer's text book on "Designing Heating and Ventilating Systems" gives the transmission of various types of radiators under standard conditions. This table used in connection with the chart should fulfill nearly all conditions met with in heating work.

Type of Radiator	—Height of Radiator.— 22-in.	26-in.	32-in.	38-in.
1 column	1.90	1.86	1.83	1.80
2 column	1.80	1.75	1.71	1.67.
3 column	1.70	1.65	1.60	1.54
4 column	1.60	1.55	1.50	1.45
Window radiator				1.85
Pipe coils				2.00
Wall radiator (horizontal)				1.95
Wall radiator (vertical)				1.90

An Experiment With Ozone as an Adjunct to Artificial Ventilation

By A. M. Feldman.

(Presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York, January 20, 1915.)

Another successful run during the summer of 1914 has been made of the cooling and ventilating plant in the small ward of the Mt. Sinai Hospital, New York. This plant was installed for the purpose of treating gastro-enteritis diseases of children. Although the success with which it was used in the summer of 1913 directly following its installation, was highly satisfactory, its usefulness was considerably augmented by the addition of an ozone machine the past summer.

The plant, as it has been described in a paper presented by the writer before this society at its annual meeting of 1914 (published in The Heating and Ventilating Magazine for February, 1914), was designed to deliver a sufficient quantity of fresh, cleaned and cooled air, for an average of three small children. This equals about 250 cu. ft. per minute. The vitiated air is allowed to escape through two open window transoms.

Notwithstanding the quantity of fresh air supplied there always has been a decidedly unpleasant odor due to the character of the periodical discharges by the children under treatment. The writer felt that an attempt to eliminate this odor by means of an augmented delivery of fresh air would have been prejudicial to the safety of the children and nurse in charge on account of draughts and aside from this objection, the cooling machine would have proven inadequate for cooling the increased amount of air.

The writer, therefore, thought it would be a good opportunity to test the efficacy of the claim being made for ozone as a neutralizer of odors. Through the kindness of the Hudson Ozone Machine Co., which volunteered to furnish the writer with some of its small machines, the experiment to which refer-

ence is made, was accordingly undertaken. The machine was placed at the end of the room farthest away from the fresh air register—near the window. The small fan in connection with this type of machine was removed to prevent the causing of draught by the violent movement of the cool air.

It is gratifying to the writer to be able to report that the experiment proved a success. That the use of ozone has neutralized the odor above referred to, has been attested to by the nurse in charge, and by the attending and visiting physicians. It was especially marked when, on a few occasions, the ozone machine got out of order. The nurse was then very anxious to get it back into use, as she had been rendered more strongly susceptible to the odor by its very absence.

This single personal experience has satisfied the writer of the fact that there is merit in the claim for ozone as an adjunct to artificial ventilation in cases where objectionable odors are being constantly generated.

District Heating

By S. Morgan Bushnell and Fred. B. Orr.

III—Velocity Steam Meters and Water Meters.

THEORY OF VELOCITY STEAM METERS.

Referring again to the fundamental equation,

$W = A \times d \times V \times K$ .... (1)

We find that a different solution is possible than that arrived at as the basis of area meters; namely, that we may assume a certain orifice or area of constant cross-sectional area "A," and allow the changeable steam flow to be measured in terms of the resultant variation in velocity. This law forms the basis of the so-called velocity meters. The basic principle of velocity meters is, in the last analysis, not essentially at variance with the area meter, since there is involved in either the element of pressure differential. This type, however, embodies the application of the well-known idea of the pressure equivalent of velocity which is familiar to engineers generally, as exemplified by the Pitot-tube, Venturi-tube, throttling disc and modifications thereof.

PITOT-TUBE.

The Pitot-tube was first used by the inventor Pitot, about 1837, for the measurement of water in pipes. Since then it has been applied to other liquids and gases, and finally to measuring steam flow. While there are numerous modifications of the original design the principle remains the same. To illustrate, in Fig. 5, let A-B represent a pipe or conduit through which water flows with a velocity "v" feet per second. Insert two open tubes into the pipe as shown, one marked "D," having its opening pointed against the flow "V"; the other tube S, having its opening at right angles to the flow. The tube S is known as the static-tube, and at all times is subjected only to the pressure due to the static condition. In other words, it is independent of the velocity (neglecting for the moment the slight aspiration or suction effect). The tube D, known as

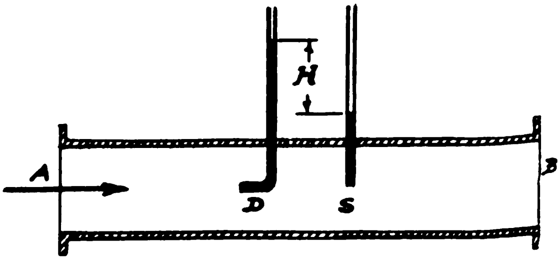


FIG. 5—DIAGRAM ILLUSTRATING PRINCIPLE OF PITOT TUBE.

the dynamic-tube, is also subjected to the static pressure, and under no flow conditions this pressure will equal that of the static tube. When a velocity is created, however, the dynamic-tube receives the impact of the moving particles of fluid in addition to the static pressure and thus water will rise in the tube "D" to a height (H) above the level in the static-tube, upon which, as we have just observed, the impact has no influence. The height (H) is an ex-

TABLE I.—CLASSIFICATION OF STEAM METERS.

		Primary Element	Secondary Element	Inventor or Maker		
Area Meters. (Velocity constant.)	Series type.	Floating Valve	Mechanical control, clock and chart.	St. John	1893	†o
				Gehre	1896	†o
				Baeyer	1902	†o
				Bendeman	1902	†
				Sargent	1908	†
				Lindmark		†
				Rhenania	1910	†o
Velocity Meters. (Area constant.)	Shunt type.	Impeller in current of steam	Gears and dials	Lindenheim	1896	*
				Gebhardt	1908	*
	Series type.	Pitot tube	Mercury manometer	General-Electric	1910	†o*
				Republic	1914	†o*
				Bristol	1912	†o
			Water manometer	Burnham	1906	
				Gebhardt	1910	†
		Stationary or throttling disc.	Mercury manometer	Halwachs	1907	†o*
				Gehre	1907	†o
				Sarco	1910	†o*
				Storrer	1910	†o
		Venturi tube	Bourdon manometer	Eckhardts	1903	†o
			Mercury manometer	Bristol	1911	†o
			Mercury manometer	Parenty	1886	†o
				Herschel	1910	†o*
		Impeller in current of steam	Gears and Dials	Holly	1880	*

† Indicating. o Recording or Autographic. * Integrating.

act mathematical function of the velocity V, being the potential equivalent of the kinetic energy due to the velocity. The mathematical relation of these phenomena is represented by:

$$V = \sqrt{2gh}\text{; or } h = \frac{V^2}{2g} \quad \ldots\ldots\ldots (3)$$

where V = Maximum velocity of flow in feet per second.

h = Difference in level in feet of water column.

g = Acceleration of gravity = 32.2 feet.

The foregoing will be understood as applying only to the flow of water. When it is attempted to measure velocity of steam and other gases by this method more complicated calculations are necessary. The reason for this lies in the substance used in the tubes to indicate the unbalanced pressures. Water is not a satisfactory agent for accomplishing this, and oils and mercury columns have been employed, the latter having proven the most successful. Thus the simple equation given must be elaborated so as to consider the different densities of the flowing and the indicating substances. If mercury is used instead of water, to indicate the velocity the solution is as follows:

$$Hw = Hm \times \frac{dm}{dw} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

in which,

Hw = Height of water column.
Hm = Height of mercury column.
dw = Density of water.
dm = Density of mercury.

Substituting in (3) we have—

$$V^2 = 2g\left(Hm \times \frac{dm}{dw}\right) \quad \text{or.}$$

$$V = \sqrt{2g \times \left(Hm \times \frac{dm}{dw}\right)} \ldots\ldots(8)$$

$$\sqrt{2g \times \left(Hm \times \frac{13.6}{1}\right)}$$

$= 29.6 \sqrt{Hm}$, feet per second.

This value when substituted in (1) gives the quantity of fluid flowing per unit of time. This formula, as will be seen later, applies to the various other types of velocity meters, including the Venturi. The above considerations are theoretical, to be sure, but actual prac-

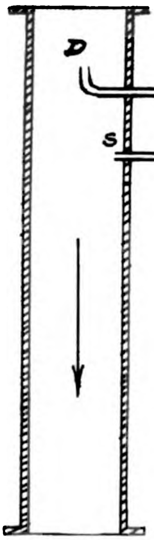
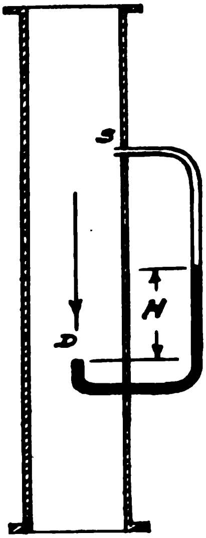


FIG. 5A—ACTION OF PITOT TUBE, SHOWING UNBALANCED PRESSURES.

tice agrees approximately with the results given. By substituting proper values for density, we may in a similar manner compute the flow of steam, using either water or mercury indicating columns, since each is heavier than the measured substance.

Unsuccessful attempts to introduce the impeller type of meter stimulated activity in other lines leading to the experiments of Burnham, 1906*. The earliest and most primitive form experimented upon consisted simply of a Pitot-tube leading into a common gauge glass, shown in Fig. 6.

It is needless to say that these never



FIB. 6—USE OF PITOT TUBE AS WATER MANOMETER.

attained importance until greatly modified and improved upon. By constant experimentation this meter has evolved from the crude design shown above to the form known as the Clyde or Gebhardt steam meter, which is now one of the very few meters employing water as the indicating substance. This meter is the most inexpensive meter to be obtained, but as its use is limited to the indicating feature exclusively, it is employed only for testing purposes.

GEBHARDT INDICATING METER.

This meter, shown in Figs. 7 and 8, solved the difficulties of the water manometer type and perhaps it will be of interest to describe it in detail, as one of the few commercial devices now in common use.

The steam when first introduced through the dynamic tube into the dynamic chamber at the bottom condenses, forming water entirely out to the tips of the tube, which is provided with a number of small openings at right angles to the flow; both tubes being built together,

*Armour Institute of Technology.

and inserted through the wall of a steam pipe in very simple manner. When no steam is flowing in the pipe, the condensation will rise only to the height of the dynamic tube, giving a zero reading, but when steam is flowing the column of water rises as a result of the unbalanced differential, as has been explained before. If we measure the height of the water column, at any instant, we have again approximately,

$$\frac{V^2}{2g} = Hw.$$

And since we are now dealing with steam as a flowing substance, instead of water as in equation (3) we have,

$$\frac{V^2}{2g} = Hw \times \frac{dw}{ds} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

where dw = density of water in pounds per cu. ft.

ds = density of steam in pounds per cu. ft.

The solution of (9) results as follows:

$$V = \sqrt{2g \times Hw \times \frac{dw}{ds}} \quad \ldots\ldots\ldots (10)$$

$$= \sqrt{2g \times dw \times \frac{Hw}{ds}}$$

$$= \sqrt{2 \times 32.2 \times 59.76 \times \left(\frac{Hw}{ds}\right)}$$

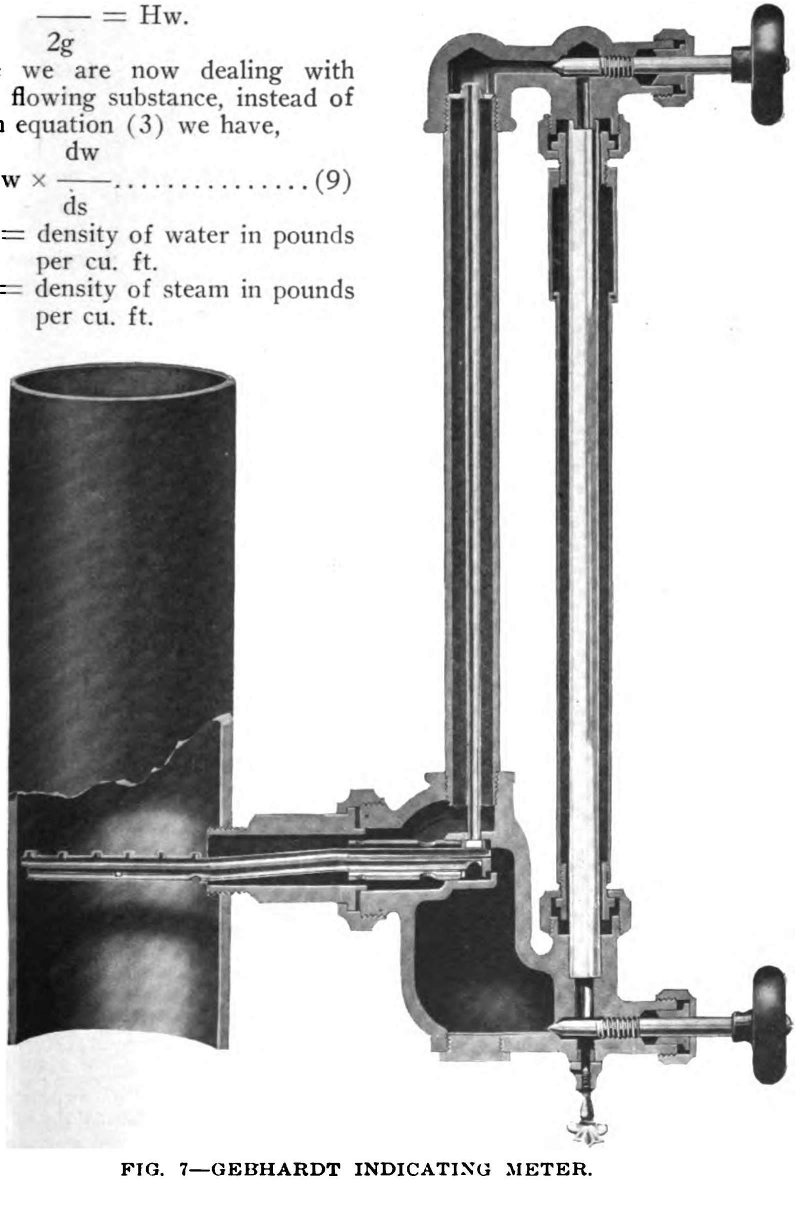


FIG. 7—GEBHARDT INDICATING METER.

$$= 62.04 \sqrt{\frac{Hw}{ds}} \text{ feet per second.} \quad (11)$$

Equation (11) represents the maximum velocity of the flowing steam. It is well known that the velocity diminishes near the edge or inside surface of a pipe due to friction; therefore, the point of mean average velocity for the section will be found somewhere between the maximum (at the center) and the wall of the pipe. This factor, which we will call K must be determined by experiment for each size pipe. The mean velocity then becomes,

$$V = 62.04 \times K \sqrt{\frac{Hw}{ds}} \text{ feet per second..} (12)$$

After determining the velocity as above the value may be substituted in the formula,

$$W = A \times d \times V \times K \ldots\ldots\ldots\ldots\ldots (1)$$

Then,

$$W = A \times ds \times 62.04 \times K \sqrt{\frac{Hw}{ds}} \text{ lbs. per sec.}$$

$$= A \times 3600 \times 62.04 \times K \ \sqrt{(Hw.\ ds)} \text{ lbs. per hr.}$$

$$= 223344 \times A \times K \sqrt{(Hw \times ds)} (12)$$

Formula (12) is the equation used for computing the charts, furnished with the meter. These charts, as will be seen, are mounted upon a cylinder placed at the side of the water glass, and are graduated to read in pounds of steam per hour directly.

Before leaving the subject of velocity meters, it will be well to consider the Venturi tube, and its application to the measurement of water and steam.

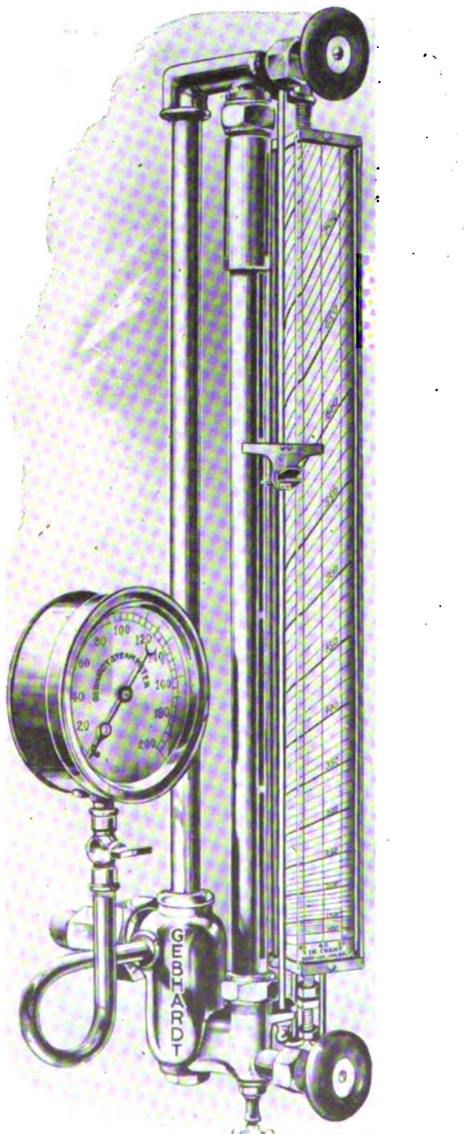


FIG. 8—GAUGE AND INDICATOR OF GEBHARDT METER.

VENTURI-TUBE.

The phenomena described below was first observed by the Frenchman, J. B. Venturi, in 1791. He did not recognize the utility of the principle he had discovered and made no use of it. It remained for Clemens Herschel, almost a century later (1887), to apply this knowledge in a practical way. The result is the Venturi meter, which has been used very extensively since that time for measuring water. The meter has since been modified for the purpose of metering other liquids and gases, including steam. Fig. 9 illustrates the principles governing the action of the primary element or tube, and Fig. 10 shows the secondary element attached.

A fluid flowing through a Venturi tube must pass the contraction B at a greater velocity than at A. After passing the point B, the velocity due to the suction effect of the expanding nozzle, returns to the normal with only a perceptible loss in pressure at C. The increased velocity at B results in a lowering of the pressure at that point, and if

a differential manometer is connected between A and B, the difference in the heights H, of the two columns will be a measurement of the velocity of fluid. This height will increase approximately as the square of the throat velocity,

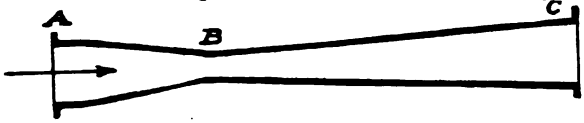


FIG. 9—DIAGRAM OF VENTURI TUBE.

$V^2 = 2\ gH$; if the velocity is doubled therefore, the height will be four times as great. Therefore,

$$W = K. \times A \sqrt{2\ gH} \ldots\ldots\ldots\ldots (13)$$

Where W = Quantity flowing per second.

K = Experimental constant which has been found to be within 2 per cent. above or below 0.98 for water at average velocity.

A = Area of throat of tube in square feet.

H = Head in feet corresponding to the difference in the pressure of the fluid entering the tube and the throat.

The Bernouilli theorem applies also in the case of the Venturi tube. A portion of the static pressure head at A is converted temporarily into dynamic velocity head through the throat B. The function of the downstream (discharge) nozzle is to regain the changed energy of the pressure head through a lowering of velocity. This is done with only slight permanent loss of pressure.

It is evident that the high ratio of contraction in area at the throat will produce relatively large differentials between B and C. This renders it necessary to use a mercury manometer, and with extremely high velocities the difference in level produced when measuring water will be as high as 22 in. corresponding to a differential of $22 \times 0.4908 = 11.8$ lbs. per square inch.

Thus it will be seen that the facility of accurately reading the manometer levels or of automatically communicating same to recording devices is greatly enhanced by the great range of measurement as compared with the much lower differentials obtained by the Pitot-tube. This difference is somewhat reduced, of course, for steam flow due to the lower density of steam.

The coefficient of this instrument at average load is 98 per cent. At low velocities the coefficient is greater and at high velocities lower, varying through the guaranteed range by not more than 2 per cent above or below. The Venturi water meter is extensively used for boiler feed water service, and if care is observed in selecting a tube of proper proportions, it gives very satisfactory results. The accuracy is questionable below 8 per cent. of the maximum rate of flow, and the meter will under-register. As a steam meter, it is probably to be recommended only for superheated steam, as moisture will affect the accuracy to a great extent.

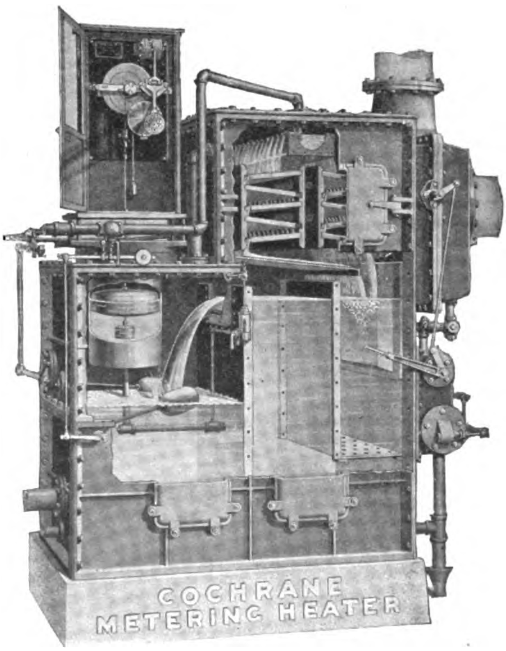
WATER METERS.

Several methods are available for metering the boiler feed supply. These are:

(a) *Displacement Meters,* consisting of:

(1) Revolving vanes or discs, and

(2) Reciprocating plungers or pistons, geared to dials which record the volume in suitable units: viz.: cubic feet or gallons.



COCHRANE "V-NOTCH" WEIR WATER METER FOR BOILER FEED.

(b) *Velocity Meters,* operating on the well-known principle of the Pitot tube or Venturi tube and registering velocities through appropriate mechanical manometer devices.

(c) *Weir Meters,* consisting of floats for automatically gauging the height of a stream of water flowing over or through various forms of outlet, or orifice, e. g., the "V-Notch," "Yorke" and other forms of weirs.

(d) *Gravity Automatic Weighers,* consisting of chambers or compartments which alternately fill and discharge, differing only in function from the condensation meter.

In the next article the authors will continue the discussion of meters, taking up the condensation type, meter defects and general conclusions.

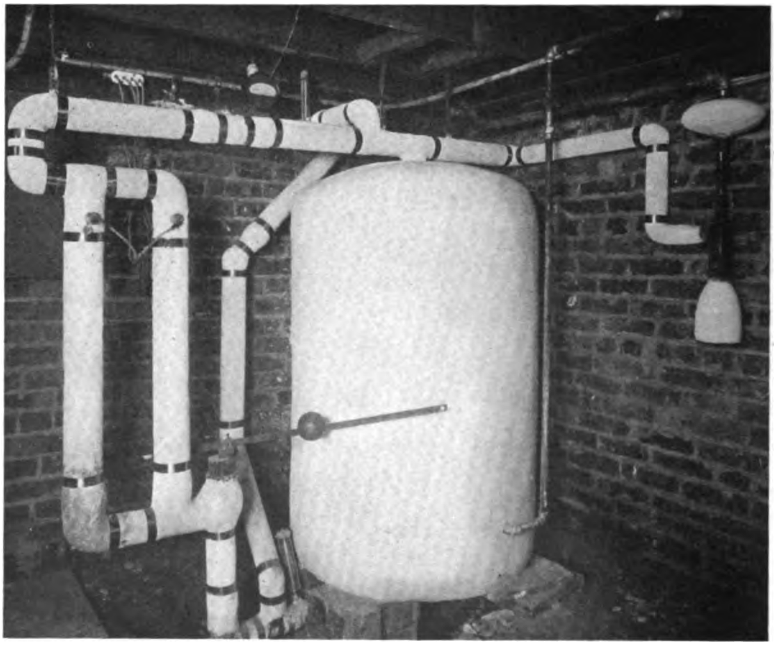
Further Developments of Electric Heating in Seattle.

Referring to the description published in the January issue of the use of electric heaters in Seattle for the heating of residences, further tests of these heaters made by the Lighting Department of Seattle, of which J. D. Ross, E. E., is superintendent, have revealed the fact that the hot water heating system is the only one that is practicable on account of the fact that it is necessary to cut off the current during the hours of lighting peak.

As will be seen from the illustrations, which are here presented in greater detail than in the January issue, these heaters are arranged exactly like a hot water boiler in the ordinary hot water heating system, and, in fact, may be used in conjunction with a hot water boiler.

The four-unit heater, as shown, is controlled by a thermostat in the return pipe which automatically cuts off the return when the return water reaches a certain temperature.

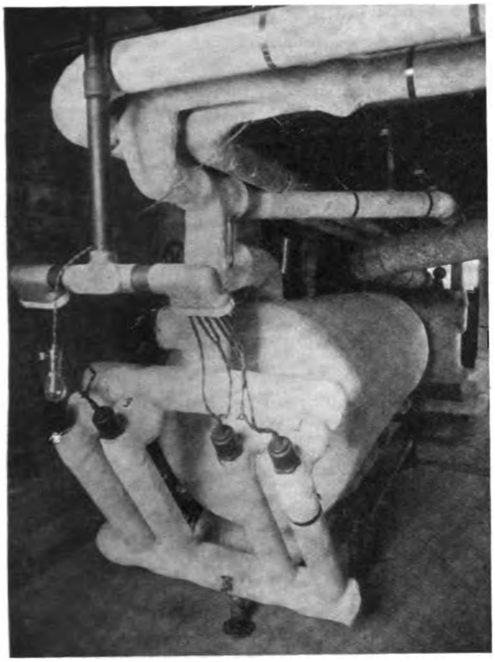
In figuring the size of an electric heater, the department has found that 1 K. W. capacity for 20 sq. ft. of radiation is the



TWO 4½-K.W. ELECTRIC WATER HEATERS, WITH 180 GAL. STORAGE, WHICH SUPPLY 250 SQ. FT. OF DIRECT RADIATION.

right proportion for the climate of Seattle. Probably in a more severe climate, 1 K. W. for 15 or 18 sq. ft. of radiation should be allowed.

With a lighting peak of 4½ hours experience has shown that 20 gal. of storage for each kilowatt of energy is needed. As noted in the report, the actual cost for energy runs from 25% to 40% higher than coal in Seattle. It will be observed that with the above factor of 20 sq. ft. per kilowatt and 20 gal. storage per kilowatt, the remainder of the heating system may be figured as an ordinary hot water system. In fact, the only difference in the operation is that the heat obtained is always the same and may be depended upon under all conditions; also, that it may be controlled from a remote point either by switch or by thermostat, or by a time clock.



FOUR 10-K.W. ELECTRIC WATER HEATERS, WITH 800 GAL. STORAGE, SUPPLYING 690 SQ. FT. OF DIRECT RADIATION.

The storage capacity enables the heater to hold over 4½ hours "peak," when current is cut off.

Tests of Open Air Schoolrooms.

An investigation of the problem of open air schoolrooms is being planned by the New York Commission on Ventilation, which is expected to definitely determine the relative advantages of open air and mechanically heated and ventilated rooms. The scheme provides for the use of six schoolrooms, each containing the same number of children of the same age, living approximately under the same home conditions; one room to be a closed schoolroom with 68° temperature and the usual closed school regime; a second room to be a closed room with 68° temperature with the open air school regime, another room to be an open air room with the usual open air school regime, another room to be an open air room with the standard closed schoolroom regime, another room to be a closed room with 50° temperature and the closed schoolroom regime, the remaining room to be a closed schoolroom with 50° temperature and the open air schoolroom regime. The 50° temperature in the last two rooms would be continued only as long as outside weather conditions would permit. It is believed that such an investigation will give a great deal of valuable information on this important subject of open air schoolrooms.

Space Requirements for Heating and Ventilating Plants.

An extensive study of the space requirements for ventilation plants has been made, under the direction of the author, in connection with forty school buildings, with the result that it has been found that approximately 1¼ sq. ft. of floor area is required in the boiler room per 1000 cu. ft. of contents of the building, with approximately the same allowance for fuel supply. The space required for the fresh air plant, that is, the fans, heaters, air washers, motors, etc., varies from 1 sq. ft. to 1½ sq. ft. per 1000 cu. ft. of space in the building, while the space required for the exhaust air plant is approximately half of that required for the fresh air plant. The height of these spaces depends upon the size of the building and its apparatus, varying from 7 to 14 ft. for the fan rooms and from 12 to 20 ft. for the boiler rooms. Usually the floor of the boiler room must be from 2 to 8 ft. below the level of the floor of the fresh air heater rooms, unless vacuum heating systems are used.

The usual size of the fresh air and exhaust flues for each standard 40-pupil classroom is found to be 4 sq. ft. in area in both the fresh air and vent flues, although a number of systems are designed with 3 sq. ft. of fresh air and vent flue area each. These areas are increased or decreased as the number of pupils per room is increased or decreased—D. D. Kimball in the School Board Journal.

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EVIDENCE is accumulating that a new spirit is spreading among heating engineers bearing upon what may be generally termed the ethics of the profession. This is reflected in such movements as that recently inaugurated in New York to promote professional efficiency and welfare; in the forthcoming promulgation of detailed suggestions for minimum heat and ventilation requirements applicable to various classes of buildings, and, finally, in the attitude of individual engineers whose feelings on the subject, we believe, are given adequate expression in the article in this issue bearing on the relation of the architect and the engineer.

The part to be played by an approved set of requirements for heating and ventilating buildings as affecting engineering ethics has not, perhaps, been given as much consideration as the matter warrants. According to the present plans, these requirements are to be widely distributed among boards of health and other bodies for their special guidance in formulating laws and ordinances in their respective localities. This will no doubt have the immediate effect of raising the question in some cases as to who is the proper authority to determine this point and what part the architect is to play in the matter.

It is becoming increasingly evident that this issue is one that must be decided sooner or later and it is just as well that it should come up over the propriety of an engineering body issuing minimum requirements for the heating and ventilation of buildings. In other words, with the rapid advancement being made in all departments of engineering, the "irrepressible conflict" between the architect and engineer can hardly be postponed much longer.

From the standpoint of division of authority the position of the engineer may be expressed in the statement that "any work the preparation of plans and specifications for which is beyond the ability of the personnel of the architect's staff, independent of advice from a contractor's or manufacturer's engineer, should be consigned to the care of the independent consulting engineer." As to the much discussed question of fees, this may be adequately covered in the statement that "there is no respect in which the work of the engineer is less expensive proportionately than the work of the architect," while the education and training are fully as extensive. Also, "in proportion to the amount of the fee paid to the engineer the cost of the engineer's plans and specifications is quite as great as the cost of the plans and specifications of the architect. . . . Why, then, should not the engineer be paid as high a rate as the architect?"

These two attitudes will appeal to many as a safe working basis and one upon which engineers may take their stand.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

42—Time Element in Heating a Building.

QUESTION: Which takes the longer time to heat a building, a steam or hot water apparatus?

ANSWER: The time element in a heating apparatus, whether steam or water, is only limited by the boiler power and size of main. There are few buildings where the boiler power is provided in excess of the usual requirements on a zero to 70° F. basis. Under such conditions it will take a long interval to heat the building and it becomes practically impossible to heat it to 70° from below 40°, if it is zero outside during the interval. If higher steam pressures and temperatures are used on the radiation, the boiler power is increased accordingly. This is readily seen as the radiation is generally provided to supply heat in the case of steam at 215° temperature with the room at 70°. If the room were down to 40°, with zero outside, the radiation would give off, according to a difference of 215 — 40, 175° F., instead of 145°.

For each increment in temperature given the room and contents, another increment has to be provided to maintain the increased loss to the outside (the amount supplied the room is getting continually less and that to the outside is constantly increasing). Suppose it was in the proportion given by the factors 175 and 145, a difference of 30, as one increment is required to raise the room temperature and one to maintain it, the increased radiation to the outside, the real increase, would be only about 15° or 55°, or the point at which the radiation and temperature balanced the losses to the outside. Of course, if an infinite time were allowed, it would nearly reach the 70° mark.

Another point seldom considered is the amount of heat absorbed by the cast-iron radiator which has 7 lbs. per square foot, with a specific heat of 0.13. This means 0.91 B.T.U. absorbed per degree raise per square foot, before the radiator will perform its function. This is given back again at some future time, but at a loss, as it generally is utilized to overheat a room after the windows are opened to cool it.

When the radiation temperature is raised sufficiently, the time may be shortened, but this means higher pressure, increased pressure drop on the mains and correspondingly greater boiler power.

There is a radical difference in the action of steam and hot water apparatus in starting. As the steam is 212° or more, all radiators, cast-iron, etc., have to be heated to that temperature before heat is given to the room. The number of sections heated in a given time will be in accordance with the boiler power provided. The maximum heating effect will be given off with a low temperature of the room at the start, delaying the time of heating the last radiator on the line which will receive no steam until boiler power is available, due to a raise in temperature of the air about the first section or section of rooms, reducing the steam consumption.

Hot water, on the other hand, has its minimum heating effect at the start, due to the water and room temperature being the same, and heat is not transmitted from the radiator until the water is heated above the room temperature. Therefore, the time may be the same as the steam, but all radiators will be heated nearly at once and some heat will be transmitted to the end of the line.

This is more or less of a theoretical discussion of the action of the two systems and the points would not be brought out unless a building were allowed to get to a low temperature in extreme weather. This, however, has occurred in some cases and it has been proven that with the ordinary system installed to provide for 70° in zero weather, the building did not get warm until the weather moderated without.

It will be found in practice if an economical system is installed, whether steam or water, that it will be much cheaper to maintain the heat continuously than intermittently. It is acknowledged, however, where a system has a constant temperature of the medium and no automatic heat control, that the overheating of the building through the day requires to be shut down at night to take care of the waste heat which would otherwise go out through open windows.

This discussion refers more particularly to large plants where the boiler power would be appreciable. In small house heating plants, it is generally possible to force the boiler sufficiently to overcome temperature conditions.

43—Loss in Pressure in Rectangular Air Ducts.

QUESTION: Will you kindly give me an authentic formula which will enable me to figure the loss in pressure due to friction in a rectangular air duct? I am desirious oftentimes of knowing pressure losses in very off-size pipe, such as 80 in. x 12 in., or 76 in. x 14 in. Also kindly differentiate between blast and exhaust systems.

ANSWER: In Konrad Meier's book on "Mechanics of Heating and Ventilation," Chart VII, on Page 124, covers the subject of air blast at high velocities. There is also a logarithmic chart published in the back of the catalogue of the American Blower Company in connection with the use of Sirocco blowers. The formulas are as follows:

Pressure in pounds per square foot to create velocity $P_v = 0.075 \frac{V^2}{2g}$

Pressure in pounds per square foot to overcome friction $P_f = 0.075 \times 0.032 \frac{V^{1.9}}{2g} \frac{1}{d^{1.18}}$

$2g$ = acceleration of gravity = 64.32.
V = velocity in feet per second.
l = length in feet.
D = diameter in feet.

The above-mentioned charts refer only to round pipe and the results can be applied to square and rectangular pipes by modifying the quantities by the following factors:

Ratio sides: $1 \times 1 = 1.15$; $1 \times 2 = 1.23$; $1 \times 3 = 1.36$; $1 \times 4 = 1.5$; $1 \times 5 = 1.65$. The formula for the factor is [Periphery of square duct ÷ (diameter round duct same area × 3.1416)]$^{1.18}$

Whether the ventilation is exhaust or blast is only one of difference in pressure drop, except that in the former gravity sometimes assists. Gravity velocities and friction formulas, with charts, are found on Page 142 of Meier's work.

Blowers Damaged by Frozen Lubrication.

Two blowers, used in a foundry to obtain the blast for cupolas, were severely damaged, due to frozen lubrication. These were located in a room seldom occupied, and for this reason the rooms were not furnished with heat. Only one fan was used at a time, the others being held in reserve.

The lubrication was fed automatically to each fan. During a period of cold weather this thickened and failed to properly lubricate the fan bearing which, becoming hot, broke loose and damaged several blades. The foreman not knowing the cause for the accident, threw into service the remaining fan with the same disastrous results. The accident necessitated the closing of the foundry for two days until new fan parts had arrived.

Engine Condensation, with Particular Reference to Exhaust Steam Heating.

One of the subjects that has been much discussed of late is the heat loss in an engine cylinder due to condensation. The matter was brought up at a recent meeting of the New York Chapter of the Heating Engineers' Society, and, more recently, at the annual meeting of the society itself. Papers on the subject were presented by Perry West and David Moffatt Myers, reports of which were published in the February issue.

The following further discussion of the subject has been presented by Mr. West:

"In my discussion of 'Engine Condensation, with Particular Reference to Exhaust Steam Heating,' I was not endeavoring to present anything new in the thermodynamic field, except in so far as the usual method of estimating the amount of engine condensation, due to the work in the cylinder, is concerned. I speak of this theory as differing from usual practice for the reason that I think it will be found that engineers and authors generally assume that the exact heat equivalent of the indicated horsepower of an engine is taken out of the cylinder feed in the cylinder. In other words, I believe that there is a much too generally mistaken idea that the work of admission is done at the expense of heat in the cylinder feed, and that the negative work during exhaust adds heat to the cylinder feed; whereas the only factors of the work which are involved in the condition of the cylinder feed at exhaust are the work of expansion and the work of compression.

"Upon first thought it would seem, according to the law of the conservation of energy, that the net work done in the cylinder should be the exact measure of the heat loss due to work. This would be true, provided there was no work transferred through the steam to the piston from external sources, or from the piston through the steam to external matter during the cycle. Inasmuch as both of these conditions maintain, they must be taken into consideration in the application of this law of the conservation of energy.

"To make this matter clear, I would refer to Fig. 1 where x-x is the axis of zero

pressure and y-y the axis of cylinder volume. BAK represents the end of the steam and ABCDEF an ordinary indicator card. Starting with a clearance space full of feed at initial pressure, steam is admitted along the line BC to the point of cut-off, C, and an amount of work is done, represented by the area, BCHK, which we will call the work of admission. This work is performed on the piston by the steam between the piston and the boiler, acting as a medium for transferring the external work of evaporation from the boiler to the piston. In other words, the

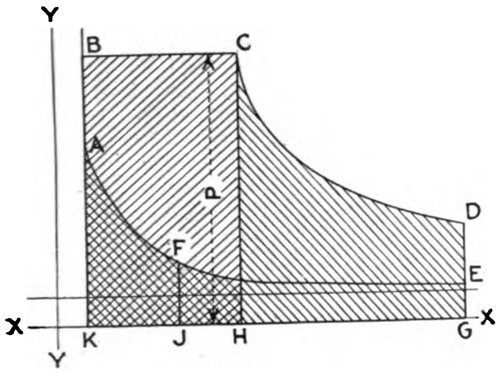


FIG. 1—DIAGRAM ILLUSTRATING MR. WEST'S DISCUSSION OF ENGINE CONDENSATION.

process of evaporation in the boiler is forcing newly generated steam out to take the place of the admission steam and in doing so is performing work against the receding steam, which, in turn, is transferring this work to the piston.

"Practically speaking, no more work is being given to the piston by the steam than is being given to the steam by the external work of evaporation, so that no net work is being taken from the steam itself. There is practically no expansion of compression of the steam and no heat loss due to this work. This can be illustrated in another way by reference to Fig. 2 T is a tank filled with water to a certain level and connected from the bottom to cylinder, C, having a tightly fitted piston, P. L is a supply line which automatically keeps the water in the tank at the same level.

"Now, as the piston moves forward, due to the pressure of water, a certain amount of work is done, but no potential energy is deducted thereby from the water in the tank. The work is simply performed by raising the water to the top of the tank and is put in at that end and taken out at the other and transferred to the pison.

"The water entering the tank may be likened to the newly-generated steam in a boiler, and the water between this and the piston, to the steam between the boiler and the engine piston. In either case, we have a volume of fluid retaining a constant potential energy, but transferring other energy from an outside source to a moving piston.

"After cut-off, expansion takes place along the line CD, Fig. 1, and performs an amount of work on the piston represented by the area CDGH. This work, unlike the work of admission, must come from the cylinder feed itself, since there is no other source in communication with the cylinder from which it might come.

"At D release occurs and a portion of the steam is expelled from the cylinder by virtue of its own pressure being above that of the exhaust. At the beginning of the exhaust stroke, there is a cylinder full of steam at exhaust pressure which must be expelled against this pressure. During this stroke, therefore, there is a certain amount of negative work done, which is sometimes considered as putting heat back into the steam. This is not true as long as the exhaust valve is open, since we have the same conditions as prevail during the admission where work is not done on the

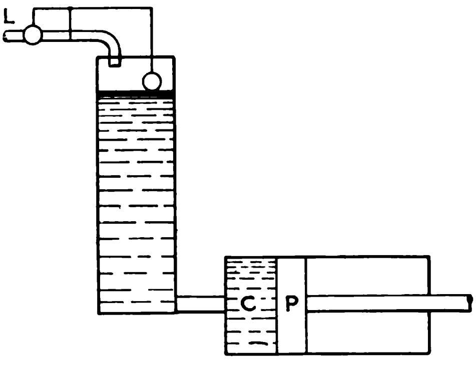


FIG. 2—DIAGRAM OF EFFECT OF WATER PRESSURE ON PISTON.

steam, but through same on some other body. This work ensues without either adding or subtracting heat from the steam until the beginning of compression. During compression the same conditions maintain, of course, as during expansion, except that work is done upon the steam, instead of by same.

"An amount of heat, therefore, is added to the feed during compression equivalent to the work represented by the area AFJK. This completes the phenomena as far as the influence of the work on the heat changes of the feed are concerned.

"In estimating the amount of condensation in any cylinder due to the work, we would, therefore, proceed as follows:

"Take the total absolute indicated horsepower, BCDGK, and deduct from same the horsepower of admission, BCHK, and then add the horsepower of compression, AFJK. Next, reduce this to its equivalent B. T. U. per hour and deduct from this the B. T. U. given up by the feed between admission and exhaust pressure. Divide this result by the latent heat of steam at exhaust pressure to get the total pounds of condensation per hour, and then by the total pounds of feed per hour, to get the condensation per pound of total feed. Then multiply by 100, to reduce to a percentage basis.

"Neglecting compressions, which exert almost a negligible influence, this may be reduced to a formula as follows:

$$C = \frac{H.P. - \dfrac{(Q \times 144 \times P)}{33000 \times 60} \times \dfrac{33000 \times 60}{778} - W\,(H_1 - H_2)}{W \times H_3} \times 100$$

Where C = percentage of condensation due to work in the cylinder.

H.P. = the absolute indicated horsepower, as explained above.

Q = the cubic feet of dry steam indicated per hour between admission and cut-off (not the entire cylinder feed).

144 = square inches per square foot.

P = absolute initial pressure, as shown in Fig. 1.

33000 = foot-pounds per minute per horsepower.

60 = minutes per hour.

778 = foot-pounds per B.T.U.

W = total weight of cylinder feed per hour.

H_1 = total heat of steam at initial pressure.

H_2 = total heat of steam at exhaust pressure.

H_3 = latent heat of steam at exhaust pressure.

This formula reduces to

$$C = \frac{2545\ H.P. - 0.185\ Q \times P - W\,(H_1 - H_2)}{W \times H_3} \times 100$$

"It will be seen from the above that there is quite a bit of the work done in the cylinder which does not cause condensation. Also, that the more wasteful the engine the dryer will be the exhaust, other things being equal. Also, that the latter the cut off, the greater the work of admission and the less the condensation due to work. Also, that where cut-off occurs at or near the end of the stroke, as frequently occurs with a pump, little or no condensation may be expected.

"This may help to explain why we sometimes get more exhaust steam for heating purposes from an engine than would otherwise be expected."

LEGAL DECISIONS

Court of Appeals on Multivane Fan Case.

The patent suit brought against the B. F. Sturtevant Company of Boston by the Sirocco Engineering Company, which has been in the courts for the past six years, has just been decided by the United States Circuit Court of Appeals for the Second Circuit, in favor of the Sturtevant Company.

It was claimed that the Sturtevant multivane fan infringed the Sirocco Company's patents, and in the lower court this claim was sustained. The Court of Appeals, however, reversed the former decision and held that there was no infringement. The Court of Appeals further decided that the Sirocco patents in suit were void in view of the development of the fan building art prior to the alleged inventions upon which these patents were based.

As there are probably more multivane fans in use than any other make, the monetary consideration at stake was large.

Heating Plant for Schoolhouse—Enforcement of Contract with School District.

Action was brought to recover the contract price of a heating and ventilating system which the plaintiff had installed in the defendant's schoolhouse during the fall of 1911. The action was in assumpsit. The original contract had been destroyed by fire and the defendant denied the correctness of the copy produced by the plaintiff. The plaintiff contended that the plant was installed under an absolute contract of sale. The defendant did not dispute the price, but alleged that it was installed under a contract allowing it to try the plant for a specified time and to pay for it if it proved to be as represented, and the plant was rejected after such trial, because it was not as represented. The trial court directed a verdict for the defendant, on

the ground that an action in assumpsit would not lie, and the plaintiff's only remedy was by mandamus, the claim being liquidated. It was held that the demand was not a liquidated liability, nor was it made such by the admission of counsel for the school district that the liability was either for the amount named or nothing. The plaintiff's remedy, therefore, was assumpsit, and not mandamus. The term "liquidated," when used in reference to claims against municipal corporations enforceable only by mandamus, signifies claims on which the amount due is either fixed by law or has been ascertained and agreed upon between the parties. The primary purpose of the writ of mandamus is to enforce duties created by law, and it is not designed as a remedy for the collection of debts. It was therefore held that it will not lie to enforce the liability of a school district on a contract for the purchase of a heating plant.

The defendant's moderator testified that the furnace was installed in a satisfactory manner, and no question was raised as to the material used. Evidence for the plaintiff tended to show performance, on its part, of the contract relied upon, and that, when properly operated, the system would produce the results guaranteed; namely, that it would heat the schoolroom to 70° F. during the coldest weather and furnish thorough ventilation during school hours. The plant was used during November and December of 1911, and for some time after the holidays. The teacher then in charge testified that she had difficulty at first in keeping the children warm, but, after being instructed by a representative of the plaintiff, she had success with it, and heated the room properly, being able on a cold morning to reach a temperature of 100°; that the ventilation, in her opinion, was all right, and she used the system as they would let her. Other evidence was introduced tending to show its successful operation. The judgment for the defendant was reversed and a new trial granted.—Waterman-Waterbury Co. vs. School Dist. No. 4, Michigan Supreme Court, 150 N. W., 104.

Use of Sidewalk Gratings in Subway Ventilation.

In connection with the agitation for some means of ventilating the new subways in New York that will obviate the use of sidewalk gratings, a plan has been proposed by George Hallet Clark, engineer, which includes air exhaust ducts directly under the trolley car tracks leading to such open spaces as the city's public squares. According to the present plans of ventilating the subway, the air will be driven out through sidewalk gratings, partly by the piston action of the trains and partly by fans installed for that purpose.

This plan has brought forth much criticism on the ground that the outrushing air would be particularly unsanitary and objectionable to passersby, especially as some of the gratings are to be located in front of the more important stores and hotels on Broadway.

At a recent meeting of the Broadway Association, a campaign was inaugurated against the use of sidewalk gratings as ventilators, the speakers including Chairman William R. Willcox, Chief Magistrate McAdoo and Reginald Pelham Bolton. The association empowered its president, Jefferson DeM. Thompson, to appoint a committee of five to call upon the engineers of the Public Service Commission and express the association's opposition to the gratings. Mr. Bolton declared that the air in the subway can be washed without cutting any openings in the sidewalks and the subway made as desirable a place to travel in as the open country.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter Takes Up "Measurement of Air Flow."

Arthur K. Ohmes, of the engineering firm of Nygren, Tenney & Ohmes, New York, was the principal speaker at the February meeting of the New York Chapter, his subject being "Measurement of Air Flow." Mr. Ohmes took up the development of methods of air measurement from their inception, and during the course of his address exhibited various devices for measuring the velocity and amount of air flow, including a carefully made German device that registers an air pressure as low as 1/5000 of an inch of water.

Mr. Ohmes opened his address by stating that instruments for measuring the flow of air can be divided into seven classes, as follows: (1) Direct reading velocity meters; (2) anemometers; (3) pitot tubes and impact discs; (4) Venturi meters and throttling nozzles; (5) volume meters by adding heat to the air to be measured; (6) long distance and centralized air measurements; (7) gauges and micro-manometers.

Mr. Ohmes reviewed the rapid development during the last fifteen years of accurate measuring instruments. Fifteen years ago, he said, we were satisfied to be able to read a column of water accurately

to within 1/10 of an inch. Five years ago 1/100 of an inch was considered an accomplishment, whereas to-day we may readily measure to within 1/1000 of an inch. Also, regarding air currents, ten years ago we could measure them accurately down to 1 ft. per second, while to-day we can obtain accurate measurements when the velocity is one-tenth of 1 ft. per second. Mr. Ohmes predicted that the future would see even greater refinements in this direction.

The speaker then described types of direct reading velocity meters, although he emphasized the fact that such types are not useful for accurate work. Among the devices in this class was a flue velocity meter built into the flue, but arranged for occasional removal for cleaning. He also showed a register velocity indicator of Swiss design, and a portable direct-reading velocity indicator, developed in the office of Alfred R. Wolff, with which one can readily get an idea of the air distribution in a very large plant.

Mr. Ohmes then discussed anemometers and stated that for the ordinary work required by the heating engineer the common flywheel anemometer covers practically all purposes, except at low air velocities, such as 2 ft. per second. He exhibited an anemometer especially designed to eliminate the element of friction losses. This instrument is operated by clockwork at a certain velocity, so that any additional velocity will indicate the velocity of the air current.

Pitot tubes and impact discs were next taken up. The speaker exhibited types of American and German Pitot tubes and called attention to the fact that with the American instrument it was essential to have the air strike the nozzle of the tube full on in order to get accurate readings. With the German tube the nozzle is slightly rounded so that it is not so easily affected by air striking it at an angle. He expressed his opinion that the American instrument was preferable for measuring the static pressure and the German instrument superior for measuring velocity.

Venturi meters and throttling nozzles, according to the speaker, have not been sufficiently appreciated by the ventilating engineer. In actual practice, he said, they are about the simplest means we have for getting approximately accurate results, and they are almost indispensable on feed water and water supply mains. He urged the development of something similar for the more important ventilating systems. He expressed the hope that such meters, with automatic registering devices, will come into more general use for keeping an easy and automatic control over the quality and amount of air handled and the attention the ventilating apparatus receives in general.

Mr. Ohmes then took up volume meters which operate by adding heat to the air to be measured and described the Thomas meter as typical of this class.

Speaking of long distance and centralized air measurement, Mr. Ohmes gave an interesting description of what was being done along this line in the Continent and showed photographs of such apparatus which resembled, in some respects, a modern switchboard. He said there was a great opportunity for the development of heating and ventilating systems in this respect and said the wider use of centralized measurement and control would assist materially in improving the operation of such plants.

Mr. Ohmes concluded his address by describing various types of gauges and micromanometers. As showing the importance of having accurate and delicate measuring instruments, he showed that an air current moving at a velocity of 10 ft. per second will only exert a pressure of

$$P = \frac{v^2 y}{2g \times 83} = \frac{10 \times 10 \times 1.2}{2 \times 32.16 \times 83} = 0.0295 \text{ in. of}$$

water, in which y is the density per cubic foot in ounces.

On the other hand an air current of 11 ft. velocity per second (an increase of 10%) will exert, under the same conditions,

$$\frac{11 \times 11 \times 1.2}{2 \times 32.16 \times 83} = 0.272 \text{ in of water.}$$

The difference is only 0.0047 in. of water, less than 1/200 of an inch.

He then exhibited a micro-manometer of German design, which is capable of measuring a water column to 1/5000 of an inch.

Before opening the discussion, President Timmis called on Mr. Keuffel, of Keuffel & Esser, manufacturers of instruments of precision, who told of the manufacture of air-measuring instruments and their uses.

Mr. Perry West exhibited a number of charts showing the results of readings taken in public school buildings. These varied considerably and showed the difficulty of obtaining accurate results. The tests were made on both sides of the heating coils of a hot blast system.

Willis H. Carrier spoke of the centrifugal action of the air in ducts as affecting the readings and Mr. Ohmes in reply stated that care is usually taken in making tests to insert guides in the ducts to straighten out the air currents. William J. Baldwin also participated in the discussion and asked if any tests had been made of Pitot tubes

having outlets of different shapes or sizes from the interior of the tube. Mr. Carrier stated that he had made such tests but not at different angles. At right angles, he said, there was no appreciable difference. As bearing further on the subject, Mr. Ohmes mentioned a bulletin (Bulletin 35) issued by the American Blower Company, Detroit, Mich., on "The Pitot Tube and Fan Testing" as containing valuable information for the engineer on the general subject of air measurement.

President Timmis stated that he had appointed a committee, consisting of Frank T. Chapman, Arthur K. Ohmes and D. D. Kimball, to confer with Superintendent of Buildings Miller in connection with a revision of the building code of New York.

The report of the entertainment committee which had charge of the entertainment during the society's annual meeting showed a balance on hand of $65. On motion of F. K. Davis, hereafter the entertainment committee will be appointed at the opening of the chapter's new year in April and will take care of the following year's annual dinner, as well as of any chapter affairs held during the year.

In the absence of Chairman J. I. Lyle, of the nominating committee, its report was presented by Frank K. Chew. The other members of the nominating committee are Perry West, George G. Schmidt and W. H. McKiever. The committee has named the following ticket: For president, W. H. Driscoll, New York, and George H. Knight, Newark, N. J.; for vice-president, Arthur Ritter, New York, and P. H. Seward, New York; for treasurer, William J. Olvany, New York, and Charles E. Scott, New York; for secretary, R. B. Hunt, New York, and F. K. Davis, New York; for members of the board of governors: Walter S. Timmis, Perry West, Charles A. Fuller, F. K. Davis, Wallace F. Goodnow and George D. Farnham, all of New York.

Illinois Chapter on "Trouble Jobs."

The February meeting of the Illinois Chapter was devoted to "Trouble Jobs and the Particular Methods Employed in the Correction of the Trouble." The meeting was held at the Great Northern Hotel in Chicago. J. P. Dugger opened the discussion, giving numerous instances of mistakes in boiler installations and the methods used to correct them. Others who told of their experiences in connection with trouble jobs were President Charles F. Newport, H. M. Hart, August Kehm, R. B. Hayward.

The meeting followed a chapter dinner at the Great Northern, and was opened with President Newport in the chair. The committee on air washer tests submitted its financial report, and it was voted to appropriate $100 additional for the purchase of apparatus to continue the tests. Dr. E. Vernon Hill gave an interesting report of the progress made by the committee on air washing and in response to his call for additional assistance President Newport and Secretary Bronaugh offered their services.

H. M. Hart stated that the official report of the Illinois Ventilation Commission was in the hands of the printers and would shortly be issued. He also gave the chapter a report of the society's annual meeting, held in New York in January.

Massachusetts Chapter.

President D. D. Kimball of the American Society of Heating and Ventilating Engineers was the principal speaker at the February meeting of the Massachusetts Chapter, February 9, which followed a chapter dinner at the Revere House. Mr. Kimball's talk was on the work of the New York State Commission of Ventilation and the tests conducted by that body during the past year.

The subject for the chapter's March meeting will be "Early Experiences Covering the Installation of Heating and Ventilating Plants," in which Laurence Franklin will present a paper giving a résumé of the practice of his father, the late Albert B. Franklin, who was one of the pioneers in the heating business in this country.

NATIONAL DISTRICT HEATING ASSOCIATION

Plans for Annual Convention.

Plans for the annual convention of the National District Heating Association, which will be held in Chicago, Ill., June 1-3, 1915, with headquarters at the Sherman Hotel, include papers by C. F. Oehlman, of Denver, Colo., on "Commercial End of the Heating Business;" by W. G. Carlton, of New York, on "Typical Hot Water Heating Plant;" by C. C. Wilcox, of Jackson, Mich., on "A Pressure Survey Study;" and a paper by G. W. Martin, of New York, on "Exhaust Steam vs. Live Steam for Heating."

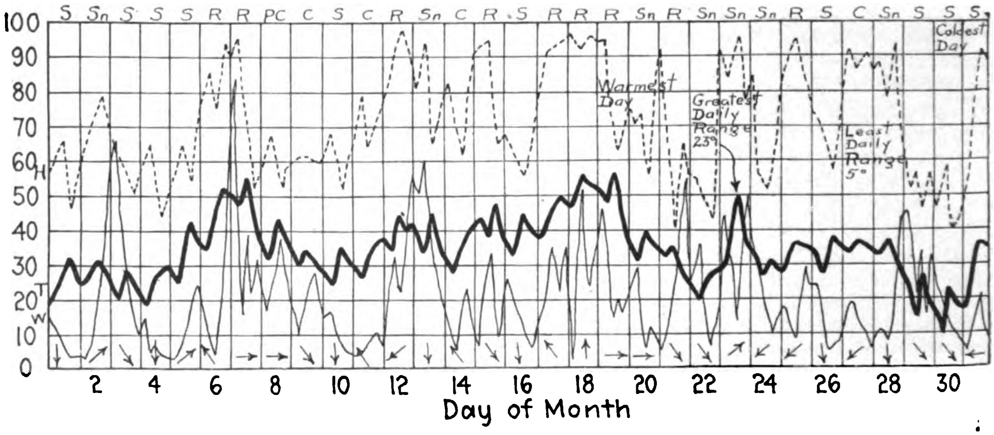
These papers are in addition to the committee reports on rates, underground construction, education, public policy, meters, station operation and station records.

It is stated there will be also three addresses by men of national reputation.

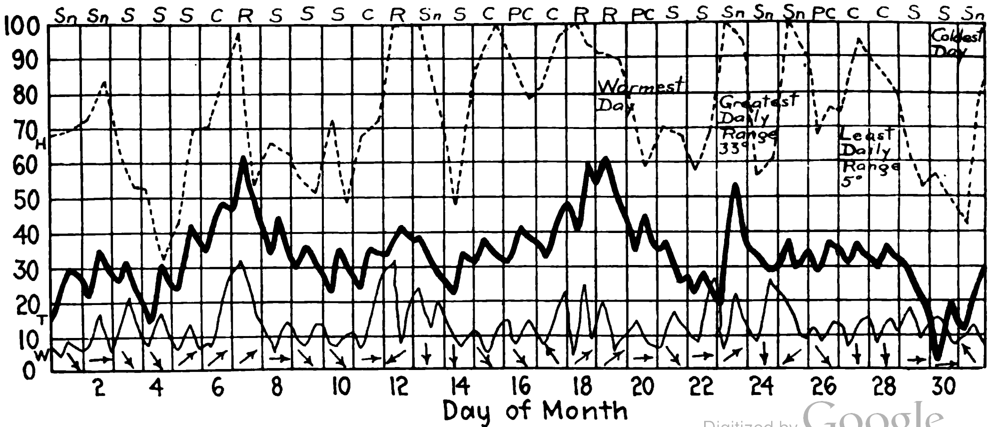
THE WEATHER FOR JANUARY, 1915.

	New York	Boston	Pittsburg	Chicago	St. Louis
Highest temperature, degrees F.	57	61	55	47	59
Date of highest temperature	19	19	17	16	16
Lowest temperature, degrees F.	10	3	4	—8	—4
Date of lowest temperature	30	30	29	28	28
Greatest daily range, degrees F.	23	33	26	23	27
Date of greatest daily range	23	23	23	24	16
Least daily range, degrees F.	5	5	5	4	5
Date of least daily range	27	27	13	12	4
Mean temperature for month, degrees F.	34.1	33	31	24.1	29.6
Normal mean temperature for month, deg. F.	30.2	27	30.7	23.7	31
Total rainfall, inches	5.61	6.33	4.66	1.99	2.83
Total snowfall, inches	4	7	14.6	6.5	11.6
Normal precipitation, this month, inches	3.79	3.82	2.87	2	2.27
Total wind movement, miles	13,088	7,951	8,156	9,015	10,046
Average hourly wind velocity, miles	17.5	10.7	11	12.1	13.5
Prevailing direction of wind	N.W.	N.W.	N.W.	N.W.	S.
Number of clear days	10	12	5	7	9
Number of partly cloudy days	5	3	6	7	7
Number of cloudy days	16	16	20	17	15
Number of days on which rain fell	17	11	18	10	12
Number of days on which snow fell	8	7	10	8	3
Snow on ground at end of month, inches	—	2.3	3	3.8	T.

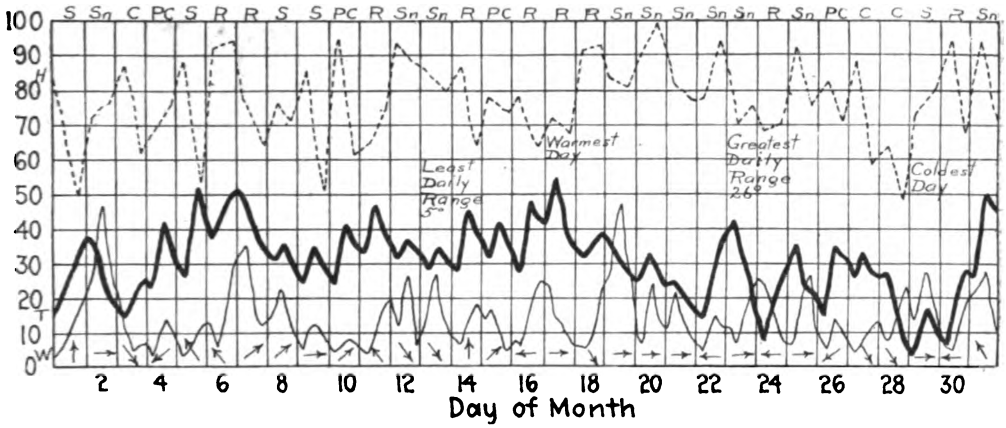
ERRATA—Lowest temperature in December, 1914, was for Boston, —2° F.; Pittsburgh, —2° F.; and Chicago,—4° F.



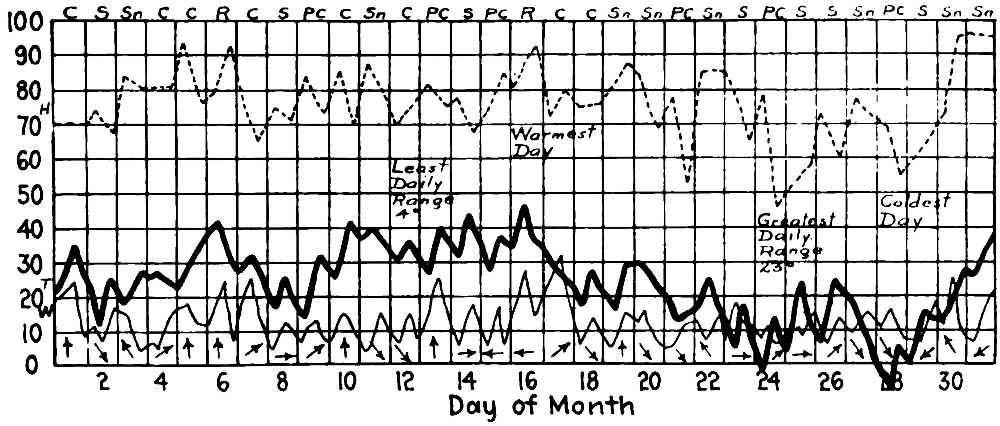
RECORD OF THE WEATHER IN NEW YORK FOR JANUARY, 1915.



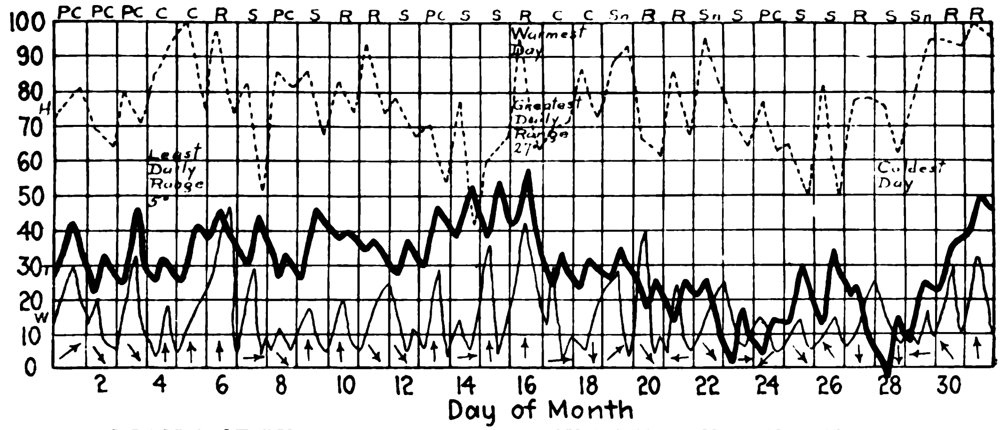
RECORD OF THE WEATHER IN BOSTON FOR JANUARY, 1915.



RECORD OF THE WEATHER IN PITTSBURGH FOR JANUARY, 1915.



RECORD OF THE WEATHER IN CHICAGO FOR JANUARY, 1915.



RECORD OF THE WEATHER IN ST. LOUIS FOR JANUARY, 1915.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, PC—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

National Association of Master Steam and Hot Water Fitters

Date Fixed for Annual Convention.

Announcement is made that the twenty-seventh annual convention of the National Association of Master Steam and Hot Water Fitters will be held in Milwaukee, Wis., June 21-25, 1915.

Wisconsin State Association.

At the fifth annual convention of the Wisconsin State Association of Master Steam and Hot Water Fitters, held in Milwaukee January 18, the following officers were elected: President, Edmund Grassler, Milwaukee; vice-president, James Smollen, Racine; secretary-treasurer, Fred Kaufmann, Milwaukee; sergeant-at-arms, Otto Biefeld, Watertown. Board of directors: F. H. Meadows, Milwaukee; E. H. Sonnemann, Sheboygan; Frank Kraft, Kenosha; Hugo Francke, Milwaukee, and George F. Reeke, Green Bay. At a dinner following the convention, held in the Elks' Club, in Milwaukee, the speakers included George F. Reeke, Attorneys William Zimmers and Leo F. Nohl, both of Milwaukee; Herman Luedke and F. E. Green.

American Society of Mechanical Engineers.

A proposed system of classifying and digesting the society's records to render instantly available all information on each particular detail of every subject treated was outlined by Edwin J. Prindle, patent lawyer, at a meeting of the American Society of Mechanical Engineers, held in the Engineering Societies Building, New York, February 9. Mr. Prindle's paper covered a plan for classifying, indexing and digesting such records so as to make it possible to turn instantly to information upon a specific subject, without the necessity for an extended research through the various papers and discussions.

New Draft Completed of Mechanical Engineers' New Boiler Code.

Announcement is made that the council of the American Society of Mechanical Engineers has accepted the report of the boiler code committee and that the code will be submitted to the society for its final approval at the spring meeting in Buffalo, N. Y., in June. The boiler code as drawn up by the committee represents work covering a period of three and one-half years, during which time the committee has had innumerable meetings and has drawn up several complete preliminary drafts. The final (fifth) revision was commenced December 15, 1914, and involved day and night sessions, at which were present an advisory committee of eighteen members appointed to co-operate with the original committee. It is probable that the enlarged committee will be made a standing committee by the society, to revise the code as found necessary.

Already several of the State legislatures are planning to make the society's recommendations the basis for legislation on the installation and operation of boilers. In the boiler law enacted in Wisconsin, which went into effect January 1, it is provided that the sections regarding new boilers shall be those adopted by the mechanical engineers' society. It is also reported that the Indiana legislature is planning to enact the code as a State law.

National Warm Air Heating and Ventilating Association.

An attendance of 59 warm air furnace men was registered at the special meeting of the National Warm Air Heating and Ventilating Association, which was held in Cleveland, O., February 17. President John D. Green presided and urged the adoption of an accurate, standard method for testing warm air heaters, so that all makers can place heating values on their own heaters, without having to go to the necessity of having to submit them to outside tests. He urged a wider co-operation on the part of the manufacturers to attain this object.

A number of interesting reports were presented bearing upon manufacturers' cost formula, a formula for warm air installations, submitted by D. Rait Richardson; dealers' costs; selling, advertising and architects; and legislation and building codes.

A recommendation that met with approval was the establishment of an official publication by the association to be sent to furnace men and, occasionally, to architects. This matter will be taken up for further disussion at an association meeting to be held next June.

Institution (British) of Heating and Ventilating Engineers.

Reports of the annual meeting of the British Institution of Heating and Ventilating Engineers, held in London, February 9, show that, although held under the stress of war conditions, the meeting was well attended and was up to the standard in interest. The chair was occupied by President H. H. Grundy. The papers presented included one on "Science in the Development of Gas Heating," by W. R. Trigg, and one on "Some Recent Theories of Ventilation Considered in Relation to Their Present-Day Practice," by E. Herring.

CORRESPONDENCE

Operating Heating Systems Under a Partial Vacuum.

EDITOR HEATING AND VENTILATING MAGAZINE:

The December issue of THE HEATING AND VENTILATING MAGAZINE contained a short article entitled, "Operating Heating Systems Under a Partial Vacuum," in which there was an error in the method of solution of a given problem. The problem was as follows:

A certain room requires 100 sq. ft. of pipe coil with a steam temperature of 220° F. to maintain the temperature of the room of 70° F., with the outside temperature at zero. How much vacuum should be carried on the system to maintain the room temperature at 70° F. when the outside temperature is 20° F.?

The pipe coil was assumed to transmit 300 B.T.U. per square foot per hour under the standard conditions of 150° difference in temperature between the steam and the room, which gives a rate of transmission of 2 B.T.U. per degree difference per square foot per hour. This is the factor usually adopted for pipe coils. In the solution of the problem, however, this factor was assumed to remain constant under all differences of temperature between the steam and the room, which is not true.

The first part of the solution is correct up to the point where the necessary transmission per square foot is determined for an outside temperature of 20° F. This was found to be 214 B.T.U. per square foot. When the pipe coil is transmitting 214 B.T.U. per square foot, the rate of transmission per degree difference is not 2 B.T.U., but something less than that, and the true rate should be determined before a proper solution of the problem can be arrived at.

The writer has found from tests and information given by various authorities that the transmission factor per degree difference for radiators and coils increases or decreases about 2% for each 10° variation above or below the standard of 150° difference, or 0.2% per degree. To illustrate the application of this, assume, as above, a pipe coil in which the steam temperature is 195° F., and the room temperature is 70° F. The difference in temperature in this case is 125°, or 25° below the standard difference of 150° for which the factor, 2, applies. The decrease in this factor, assuming as above 0.2% per degree, would be $0.2 \times 25 = 5\%$. The true value of the factor would, therefore, be $2 - (2 \times 0.05) = 1.9$. The total transmission per square foot would be $1.9 \times 125 = 237.5$ B.T.U.

Applying this to the problem under discussion, let T represent the required temperature in the coil. Then $T - 70 =$ difference in temperature between the steam and the room. To find the number of degrees below the standard difference this must be subtracted from 150 and we have $150 - (T - 70) = 220 - T$. Multiplying this by 0.2% or 0.002, we have the percentage of decrease in the factor, which is $0.002\ (220 - T) = 0.44 - 0.002\ T$. To find the true value of the factor we must multiply this by the factor, 2, and subtract, which gives us $2 - 2\ (0.44 - 0.002\ T)$.

Reducing, this gives $1.12 + 0.004\ T$, which is the true value of the factor under the assumed conditions. This expression, multiplied by the difference in temperature, $(T - 70)$ gives the total transmission per square foot which, we have already found, must equal 214. We may, therefore, establish the expression $(1.12 + 0.004\ T)\ (T - 70) = 214$.

Combining the two expressions in the parentheses gives $0.004\ T^2 + 84\ T - 78.4 = 214$, or $0.004\ T^2 + 84\ T = 292.4$.

Dividing through by 0.004, we get $T^2 + 210\ T = 73{,}100$. Completing the square of the first number and extracting the square root of both sides gives $T + 105 = 290.1$. $T = 185.1$.

The temperature of the steam should, therefore, be 185.1° F., which corresponds to, approximately, 14 in. of vacuum, instead of 16.5 in., as given in the solution.

CHAS. A. FULLER.

New York, February, 1915.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

FANS—

Heaters for Fan Work. C. L. Hubbard. Shows how to compute the size of heaters, to measure their efficiency, and to design pipe connections and determine the size of cast-iron heaters. 1800 w. Engng Mag—Jan., 1915. 40c.

The Testing of Fans, With Special Reference to the Measurements of Pressure. Thomas Bryson. Also discussion. Plate. 3500 w. Trans Inst of Min Engrs—Vol. XLVIII, Part 1. 60c.

PIPING—

Steam Piping Chart. H. D. Austin. Gives chart and explanation of its use. 1500 w. W. Engng—Dec., 1914. 40c.

VENTURI FORMULA—

Note on the Modified Venturi Formula for Flow of Gases or Vapors. G. B. Upton. Explanation of a new expression and its use. 1200 w. Sib jour of Engng—Dec., 1914, 40c.

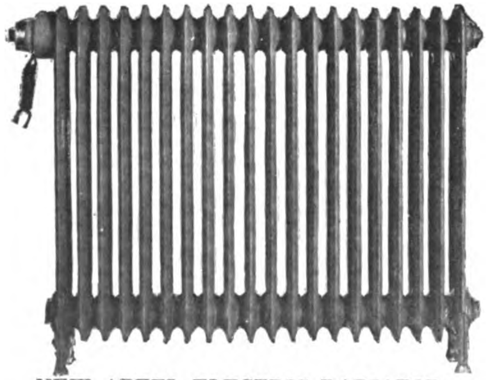
NEW DEVICES

Apfel Electric Heaters.

Two electric heating devices, one an electric hot water radiator, and the other an electric water heater for domestic purposes, have recently been patented by P. F. Apfel, of Apfel & Jansen, Seattle, Wash., contracting engineers for electric and steam and hot water heating installations. They are shown in the accompanying illustrations. The chief merit claimed for the radiator, as compared with the various types of air heaters, is that it does not become overheated so that there is no possibility of burning. Also there is no burning out of the coils because oxygen is eliminated and never comes in contact with the coils. In addition, the coils are kept comparatively cool by the circulating medium which disseminates the heat through the radiator. There is no vitiation of the atmosphere as with a coil heated red hot.

In operation this method of heating, of course, eliminates ashes, coal soot, dust, dirt, gases and unhealthy odors, with the attendant labor, to say nothing of having the basement as clean and accessible and free from dirt as the living rooms.

The Apfel system, it is claimed, can be installed at a cost that will compare favorably with that of the ordinary steam or hot water heating system. As to the cost of operation, it can be used on either direct or alternating



NEW APFEL ELECTRIC RADIATOR.

current and, in Seattle, this is supplied for ½ cent to ¾ cent per kilowatt, which, it is believed, is the lowest rate ever quoted for electric current consumption in this country.

Even at this rate the cost is considerably above that of other heating systems, but there is on the other hand the saving of time, trouble and inconvenience, while in mild winter weather it can be utilized only as required. By "pressing a button," the degree of heat given off by each radiator may be readily controlled.

A number of installations has already been made in Seattle, including the general offices of the Pacific Hardware and Steel Company,

ELECTRIC WATER HEATER.

the Great Western Stove Company and the residence of Dr. Judson W. Mather at Kirkland, Wash.

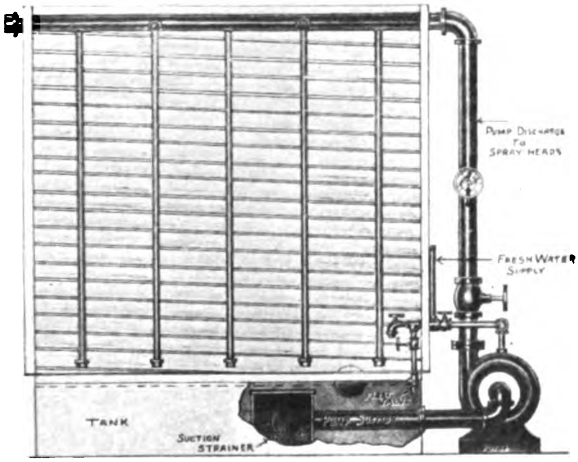
The Apfel electric water heater is of simple design and is capable of supplying tanks from 30 gal. to 30,000 gal. capacity. It is 3 in. x 30 in. in size and can be located in the basement where, it is stated, it will require no attention, no matches or even switches. The cost of operation has been found to be comparatively low, the electric companies in Seattle making special flat rates per month based upon continuous operation. The electric water heater is listed at $25.

The Ideal Air Washer.

A new type of air washer which, it is stated, is the result of over ten years' practical experience in the manufacture and erection of

different types of air conditioning apparatus, has been invented by George C. Derby, 1108 Irving St., San Francisco, Cal., and is being marketed by him. It was first placed in the market by the California Air Purifying Company, the change being made January 1, 1915.

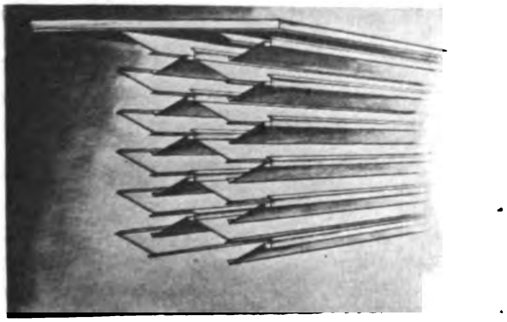
The accompanying views show the general construction of the Ideal air washer. It will be noted that the spray heads form two complete sheets of water through which all the air must pass when in operation. The elimi-



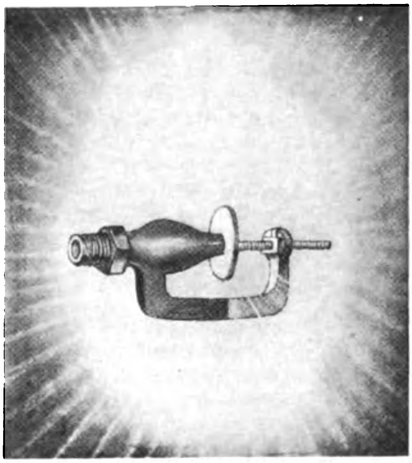
FRONT ELEVATION OF IDEAL AIR WASHER.

nator plates are set on an angle of 30°, instead of the more usual practice of 45°. It is claimed that with this arrangement there is less resistance to the air.

Special attention is called to the construction of the eliminator plates, the second and fourth rows of which have a gutter at their upper edges which drops down below the plane of the plate. This gutter has a projecting lip on its upper side which catches all free moisture that otherwise would be forced over the top of the plate by the current of air passing through the washer to the fan. The



ELIMINATOR CONSTRUCTION OF IDEAL AIR WASHER.

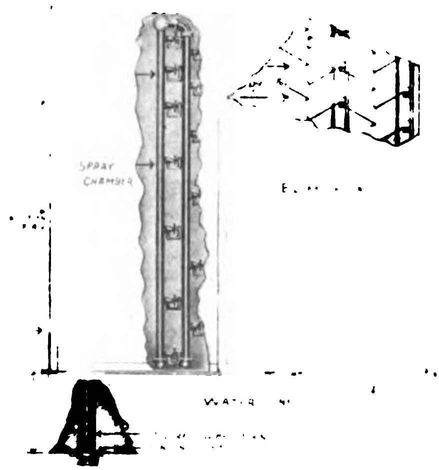


IDEAL SPRAY HEAD IN OPERATION.

gutters are inclined to one end and discharge into vertical return pipes that return all water to the tank.

The Ideal spray head is made of solid brass and is said to be non-cloggable. The water has an unobstructed passage of 3-16 in. through all its parts. There are approximately two spray heads to each 1,000 cu. ft. of air handled by the washer and, as stated, they are staggered in such a way that the air must pass through the two sheets of the spray before reaching the eliminator.

An improved strainer box, with an extra large area, incloses the foot valve. The brass screens used may be easily removed for cleaning. The water is drained from the tank by lifting out the standing overflow pipe which



END VIEW, IDEAL AIR WASHER.

has a ground joint flush with the bottom of the tank.

The company has made some notable installations of the Ideal air washer, the list including such buildings as Trinity Auditorium, Los Angeles, where the installation is capable of humidifying 100,000 cu. ft. of air per minute; also the State Normal School, Los Angeles, containing 13 Ideal air washers. An interesting catalogue entitled, "Pure Air and How to Obtain It," describes the Ideal air washer in detail.

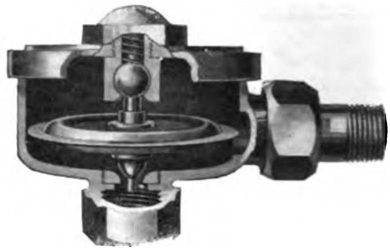
New Publications.

Heating and Ventilating Buildings, sixth edition, by Prof. Rolla C. Carpenter, revised and rewritten, has just been published by John Wiley & Sons, 432 Fourth Avenue, New York. In this edition considerable new matter has been added and the size of the book, as compared with the first edition, has been increased by nearly one-half. Since the first edition, several new chapters have been added relating to fans or blowers for moving air, mechanical systems of heating and ventilation, schoolhouse heating and ventilation, and air conditioning. The sixth edition also describes the latest improvements in the art and gives directions for the construction and installation of all the various systems now in use. A noteworthy feature of this work is the collection of useful tables and data for the use of the heating engineer. This collection is, we believe, one of the most complete to be found and adds very materially to the value of the book. Size 6 x 9 in. Pp. 605, with 290 figs. Cloth, $3.50 net. May be had through the book department of The Heating and Ventilating Magazine.

Trade Literature.

Katch-Drip, a device that fits on a radiator air valve, and which is intended to supply moisture in the form of steam for humidifying rooms, has been placed on the market by the Katch-Drip Sales Co., 419 Madison street, Brooklyn, N. Y. It is arranged to catch all water, while allowing a certain percentage of steam to escape to the room. It is stated that the device will deaden that sizzling sound from the steam when the valve is open. It is listed at 35 cents.

Reliable Return Line Vacuum Heating System, including each part of the equipment, is illustrated and described in a new catalogue issued by the manufacturers, the Bishop-Babcock-Becker Co., Cleveland, O. This catalogue, it is stated, supersedes all previous issues. Special attention is called to the company's guarantee which covers the correctness of the mechanical principles and construction of the apparatus, the testing and adjustment of all parts and, finally, an agreement to replace or repair, free of charge, any parts proven defective—ordinary wear and tear, abuse and neglect excepted—upon delivery to the company's factory for inspection. In discussing the adaptability of the system, it is stated that it is equally efficient for new or old two-pipe steam heating plants, in any style or size building. The low cost of in-



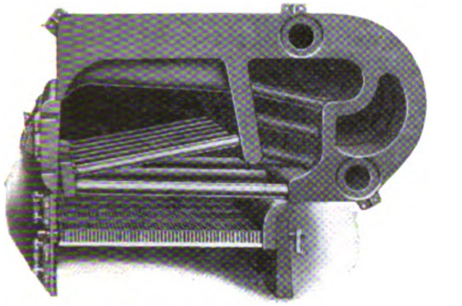
NO. 1 RELIABLE "VACU-TRAP."

stalling the Reliable system is emphasized. One section takes up in an interesting manner the equipment and changes required to install a Reliable system in connection with a steam heating plant already in operation, at the same time making it 100% efficient. The illustrations include different types of the Reliable return line electric vacuum pumps, automatic switch and vacuum controller, return line strainer, etc., while several pages are given over to a description of the "Vacu-Trap" and its operation. A double-page illustration shows a typical layout of the Reliable system. Size 5 x 8 in. Pp. 24.

Wentz Thermostat, for use in connection with a gas-heated hot water boiler, is featured in circular matter being sent out by the manufacturers, the Wentz-Yoder Mfg. Co., Engineers' Building, Cleveland, O. The device acts automatically to turn on and off the gas, as necessary. It is claimed that with this arrangement the same results are secured as with a high-priced instantaneous heater. It has no stuffing box through which gas can leak and no valve stem to pack or to stick when packed too tight. It is made with a patented system of multiple levers.

Seabury Water Tube Boiler, for stationary and marine services, is the subject of a carefully-prepared catalogue, profusely illustrated, issued by the makers, the Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated, Morris Heights, New York. This boiler is designed to meet the requirements of a light-weight boiler, occupying a minimum of floor space per horsepower, besides having the essential qualities of safety. The illustrations include sectional and other views, taken from photographs, together with all the necessary data. Size 6 x 9¼ in. Pp. 48.

BURN THE SMOKE by using Bernard smokeless boilers, is the advice contained in a new catalogue of the Bernhard smokeless down-draft boilers, issued by the mnaufacturers, the Kanawha Mine Car Co., Charleston-Kanawha, W. Va. This boiler is described as the



BERNHARD SMOKELESS DOWN-DRAFT BOILER.

lowest in stature, and the highest in efficiency. It is stated that the poorest grade of soft coal can be successfully burned, without smoke, in this boiler, and that the boiler can be successfully used on any system of heating where a low pressure boiler can be used. It is de-

HEATING WATER WITH STEAM is the title of a recent catalogue issued by the Alberger Heating Co., Buffalo, N. Y., and devoted to the Alberger multi head heaters. The company's product, as noted in the catalogue. includes feed water heaters, domestic service heaters, forced circulation hot water heaters, laundry heaters, oil heaters, condensers, expansion joints, etc. The illustrations show in detail the construction of the multi-head heater which consists primarily of a cast-iron cylinder containing straight copper tubes having helical corrugations, one end of each tube being expanded into a fixed head while the other end is expanded into a floating head. The catalogue includes views of typical installations and there are also diagrams of preferred piping arrangements to Alberger multi-head heaters. Announcement is also made that the company has placed on the market a new expansion joint known as the Ross expansion joint, the primary feature of which is the device for guiding the pipe line, so that it must necessarily be in perfect alignment with that part of the piping which is held rigid. The object of this feature is to prevent the ordinary wear and tear on packing which is often experienced with slip-tube expansion joints. The catalogue includes illustrations of this expansion joint. Size 6 x 9 in. (standard). Pp. 24.

BUFFALO PLANOIDAL FANS, described as a modification and improvement on the older type of steel plate heating and ventilating fans, with a comparatively small number of radial blades, are featured in a new catalogue (Catalogue 200) just issued by the Buffalo Forge Co., Buffalo, N. Y. With the improvements which the company has made, this type of fan, it is stated, will compete, for most conditions, on an equal basis with the multiblade fans. The catalogue contains full construction details of this interesting apparatus which for ordinary heating and ventilating work, has shown no appreciable inferiority to the most efficiently designed multiblade fans.

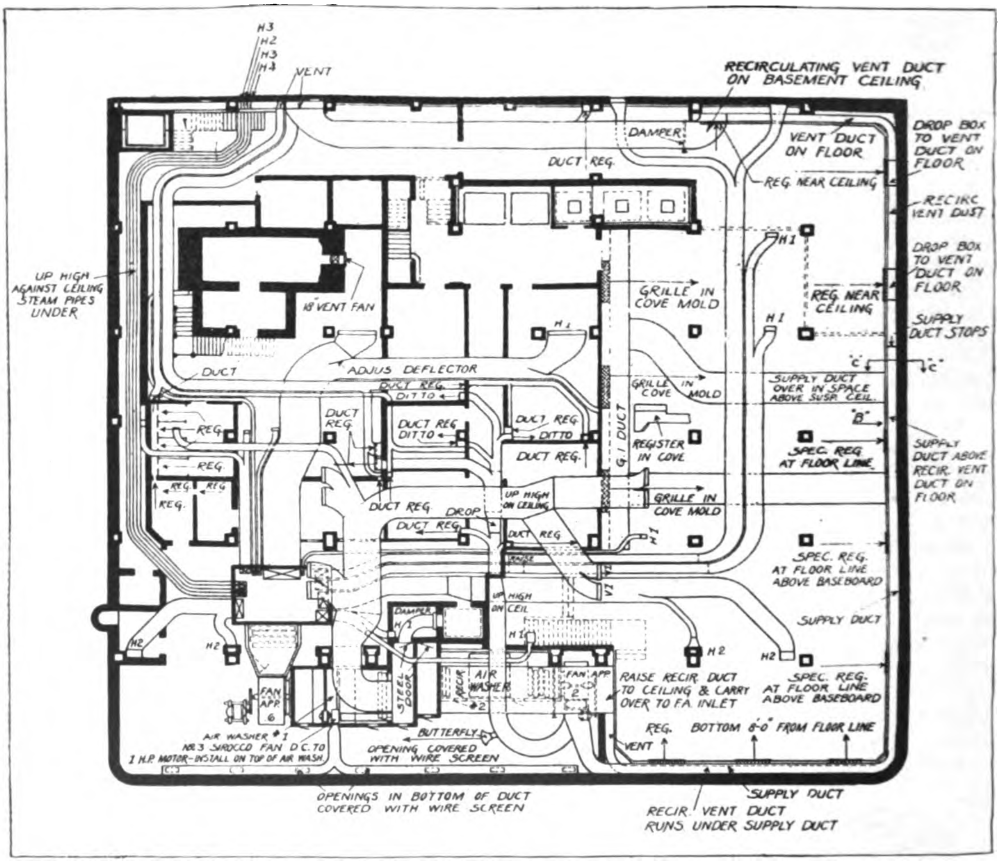
Another new publication (Catalogue 201) is devoted to Niagara Conoidal fans. In addition to having all the advantages of the multiblade type in respect to higher operating speeds, more compact arrangement, and greater rigidity, the shape and blades and proportion to the housing used in the Niagara Conoidal, makes it possible to convert into static head the velocity head, which is much higher proportionately to the total pressure with multiblade fans than with older types having few blades. This catalogue is also profusely illustrated and contains all the desired information for the use of the engineer in selecting fan apparatus.

Catalogue 182-E, also issued by the Buffalo Forge Company, is devoted to Buffalo electric fans, for blowing, exhausting, ventilating, cooling and drying. In this catalogue the various

ALBERGER MULTI-HEAD WATER HEATER, HORIZONTAL TYPE.

types of blowers and exhaust fans which are regularly built for direct connection to motors, are collected for convenient reference. The types include everything from large ventilating and drying fans down to the little Baby Conoidals for ventilating moving picture booths, drying cabinets, etc., and electric blowers for single forge fires, which take less than half the horsepower of an ordinary electric lamp. Size of each catalogue, 6 x 9 in. (standard). Catalogue 200, 48 pages; Catalogue 210, 64 pages; Bulletin 182 E, 32 pages.

VENTILATING THE FLETCHER SAVINGS AND TRUST BUILDING, Indianapolis, Ind., is described and illustrated in a special bulletin published by the American Blower Co., Detroit, Mich. The equipment includes Sirocco multiblade fans of large air handling capacity in the basement to supply fresh air, washed and tempered to the bank rooms above and to a restaurant located in the basement. An exhaust fan on the sixteenth floor removes the impure air from the building as a whole, while separate exhaust systems are provided for the restaurant and toilets.



BASEMENT PLAN, FLETCHER SAVINGS AND TRUST COMPANY BUILDING.

Sanitary Industrial Surveys Offered by the New York City Department of Health.

One of the announcements in the Weekly Bulletin of the Department of Health, City of New York, states that the department is prepared to undertake a sanitary survey of any industry, trade or group of manufacturing or mercantile establishments in New York, with a view of appraising existing conditions and in order to show to employers and workers alike what can be accomplished through a system of voluntary hygienic and sanitary control. Through its bureau of public health education, the department states that it will be glad to assist in formulating sanitary industrial standards and measures for the prevention of occupational diseases. In addition to this the bureau stands ready to prepare and furnish health leaflets especially designed for workers in any industry and to supply popular lectures on health and sanitation to such workers, in co-operation with either employers or trade unions. The director of the bureau is Charles F. Bolduan, M. D.

New York Steam Company Under New Management.

Announcement is made that A. E. Duram, formerly of the Central Station Engineering Co., of Chicago, and more recently of the American District Steam Co., of North Tonawanda, N. Y., has been elected president of the New York Steam Company, with headquarters in New York. Mr. Duram succeeds G. C. St. John. C. A. Gillham, also formerly of the Central Station Engineering Co. and of the American District Steam Co., has been elected vice-president of the New York Steam Co., succeeding C. C. Upham.

The change in management is looked upon as the beginning of a new period of development for this company which has recently been characterized as "the largest and most important company in the country and probably in the world for the distribution and sale of steam."

As announced in these columns some months ago, the New York Steam Company has been directed by the New York Public Service Commission of the First District to replace certain portions of its underground steam system with mains of more modern design. This applies to some 58,000 ft. of mains, some of which are close to the extensions of the New York subway where, it was feared, the leakage of heat from the steam pipes would destroy the waterproofing of the subway. The New York Steam Company has just accepted a revision of the order as applying to 30,000 ft. of its mains, although the type of construction has not yet been definitely determined. The work is to be done within three years, at a rate of not less than 10,000 ft. per year.

Important additions to the company's power station at the East River and 59th Street are also being made, including the installation of new boilers. A number of extensions to the company's distribution system in both the uptown and downtown districts are also to be made during the coming summer.

Building Operations for December.

December building operations in 68 American cities, according to The American Contractor, Chicago, were $34,310,484, as compared with $58,661,519 for December, 1913, a decrease of 41%. Taking the records for the entire year of 1914, the falling off was 9%. Among cities that showed gains were St. Paul, Salt Lake City, South Bend, Seattle, Denver and Oklahoma City. New York reported the largest decrease, amounting in Manhattan to 90%. Chicago showed a slight gain.

The figures for January, 1915, are slightly better. The total building operations in 75 cities, were $34,712,718, compared with $46,447,497 for January, 1914, a decrease of 25%. New York reversed its December showing by reporting a gain of 35%. The comparative loss in Chicago was 9%. The total figures for New York City were $12,532,156 as against $9,326,742 a year ago.

Cost of Heating and Ventilating Systems.

In a study of the cost of installation of heating and ventilating plants, made in a number of schools, it was found that the prevailing custom of apportioning a certain percentage of the total cost of the building for the installation of the heating and ventilating plant is of no value, as these percentage ratios vary more than 100%, even with similar classes of installations. For a given size of building, the cost of the heating and ventilating system will be approximately the same whether the building is a monumental stone structure or a plain wooden structure, but the percentage of cost of the system will be very different.

CLASSIFICATION OF SYSTEMS.

As a result of this study, the following scheme of classification has been arrived at:

Class A. Plants providing for fire-tube boilers, double fan systems, air washers and humidifiers, individual or double duct systems and modulating control of direct radiators and mixing dampers.

Class B. Same as Class A, but using automatic stokers and water, tube boilers instead of fire-tube boilers.

Class C. Same as Class A, but eliminating the modulation control of radiators and dampers and using the single trunk ducts.

Class D. Same as Class C, except that it eliminates the use of air washers and humidification systems.

Class E. All other systems.

Manifestly there are many combinations of equipment which render an exact determination of classification difficult, but in general this classification has proven satisfactory.

After a careful study of this method of classification and the figures on costs as thus obtained, it was found that the only satisfactory basis of determining the cost of the installation of the heating and ventilating plant was on the basis of the cubic feet of space in the building. The variation in costs within the different classes of systems is rarely over 10% from the average, the greatest variation occur-

ring in Class A. The resulting costs are as follows:

Class A, cost of plant per cu. ft. 2.7c to 3.3c—average 3.1c.

Class B, cost of plant per cu. ft. 3.3c to 3.8c—average 3.4c.

Class C, cost of plant per cu. ft. 2.2c to 2.5c—average 2.4c.

Class D, cost of plant per cu. ft. 2.2c to 2.3c—average 2¼c.

Class E, cost of plant per cu. ft 1.9c to 2.2c—average 2.1c.

If classes D and E were but abandoned and a proper amount of skill were used in the design, installation and operation of the remaining classes, a sufficient appropriation being provided for the installation and operation of the ventilating plant, it is believed that little basis would be left for complaint as to the success of the artificial ventilating system.

Classes D and E are the result of a too limited appropriation, a demand for too large a building for the funds available, too much ornamentation, or too much equipment, or, in other words, an attempt to build a $100,000 building with a $75,000 appropriation, the greatest sacrifice being made in connection with the heating and ventilating plant. Better were a proper building, well equipped, though smaller.

As a matter of information it is interesting to note that the cost of plumbing equipment for school buildings ranges from three-quarters of a cent to one and one-half cents per cubic foot, the average being one and one-tenths cents. The cost of electrical equipment, exclusive of electric power plants, ranges from one-half to one cent per cubic foot, the average being seven-tenths per cubic foot.

In the case of the heating and ventilating, plumbing and electrical work, the costs seem to be approximately the same in grade schools and high schools.—D. D. Kimball in the School Board Journal.

ADVERTISERS' INDEX

THE HEATING AND VENTILATING MAGAZINE

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The Edison Phonograph Shop

HEATING AND VENTILATION AT MINIMUM COST, WITH VENTILATION OF SOUND-PROOF BOOTHS.

BY C. E. DANIEL.

Most heating and ventilating apparatus dealt with in technical articles has been installed according to the best practice known to the heating engineer in charge. This is the case when there is the required space and the necessary appropriation. In many instances these things are not possible, making it necessary to locate the apparatus in space allotted by the architect and to make the installation conform to a limited appropriation. It is then necessary for the engineer to disregard practice and overcome the difficulties due to bad location of apparatus and building construction and make every dollar do the maximum amount of heating and ventilating where it is most required.

The apparatus here described was designed for and installed in the Edison Phonograph Shop under the last-named conditions. Aside from that, it has several points of interest in that it differs in many respects from the usual practice.

The building known as the Edison Phonograph Shop is located at 473 Fifth Avenue, New York City. It is of the reconstructed type, being formerly a residence with a second floor, which has been removed to make the first floor ceiling height twice what it was before the change. The first three floors are now devoted entirely to the sale and demonstration of Edison Diamond Disc phonographs. The fourth floor is to be let for offices, while the fifth floor will be used as a studio. The boiler room, fan room and shipping room occupy the basement.

From an architectural standpoint the interior decorations are of particular interest. This work consists of panelling, columns and architraves veneered with walnut, African mahogany, quarter-sawed oak and cherry. The first floor consists of a sales or show room in the front and a concert room in the back for demonstration of the operation of the phonographs. The second floor has the main office in the front with a record room and demonstration booths in the rear, as shown in the accompanying plan. All booths are of sound-proof construction and are used for private demonstration of machines or records. Three large booths, which are not shown in the plan, are located on the third floor.

MINIMUM HEATING REQUIREMENTS.

Comparatively little radiation was used in the building as none of the booths or concert hall has any glass exposure. The main store on the first floor is heated by an indirect stack located in the boiler room. Air is blown from the main heater through this stack and into

the room from a register located under the front window, thus serving as a heating medium, as well as for ventilation. Concealed radiators are located under the front windows on the second and third floors, with the usual top and bottom registers for circulating the air over the radiators.

The registers are proportioned according to the rule: 4 sq. in. for top and 3 sq. in. for bottom registers, with an addition of 20 per cent. to the radiation because of reduced efficiency.

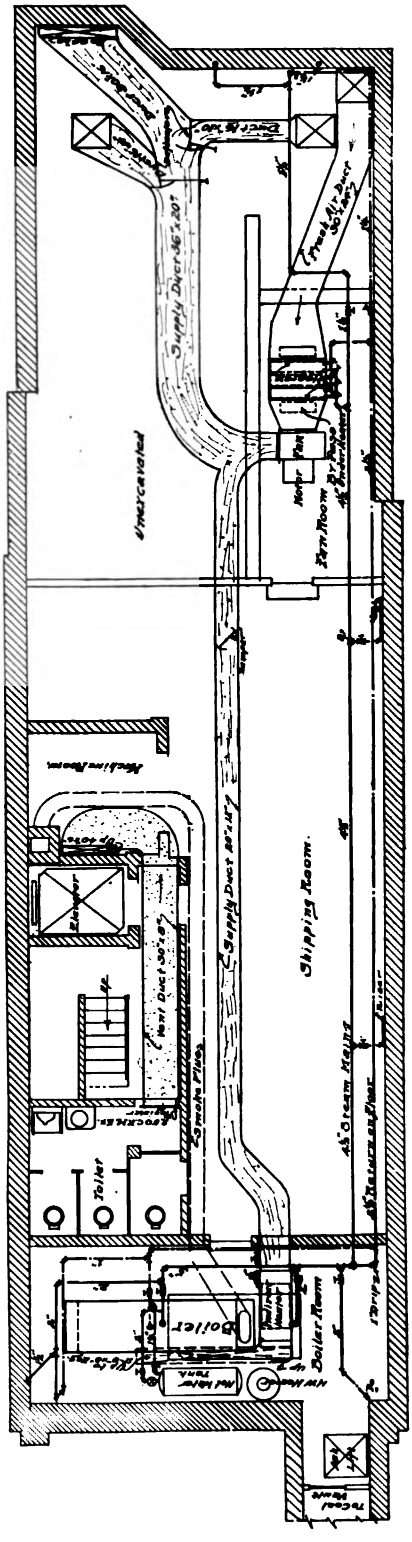
By heating the elevator shaft and stairway by a concealed radiator in the entrance hall, it was possible to supply all radiators, risers and main heater with one steam main and one return located on the south side of the building. By this arrangement, only 12 direct radiators were required, with a total of 660 sq. ft. of heating surface, including pipe coil. This is less than 1 sq. ft. of surface per 200 cu. ft. of building contents. All radiator and riser connections which are on a one-pipe system, were made one pipe size larger than the radiator or riser, except where risers were dripped.

The boiler and smoke breeching were covered with 1½-in. asbestos slab with a ½-in. air space and ½-in. hard plaster finish. All mains, branches and risers were covered with four-ply asbestos air cell covering and, in addition, the mains in the basement were sized with paper and recanvased with 8-oz. duct sewed on. All supply ducts, heaters and fan casing in the basement were covered with 1-in. asbestos air cell block and canvased.

NO OUTSIDE WINDOWS IN CONCERT HALL OR IN ROOMS CONTAINING DEMONSTRATION BOOTHS.

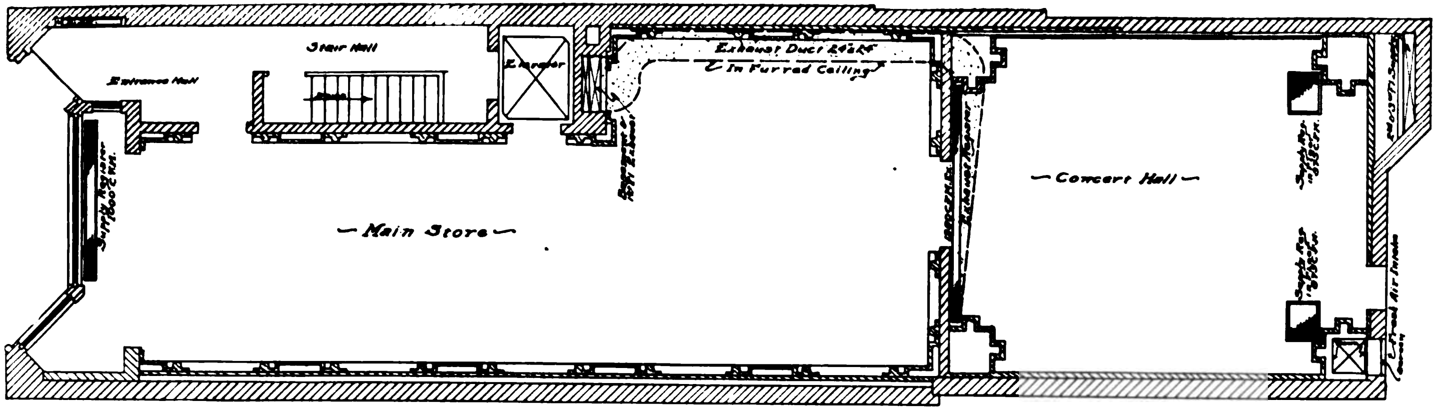
In order to get the best results from phonographs in the concert hall and demonstration booths it was necessary to make all partitions as well as outside walls, sound proof. Any sound passing from one booth to another would be as objectionable as that coming from the outside. This soundproofing eliminated any possibility of outside windows and, therefore, of natural ventilation, making forced ventilation necessary.

The concert hall has a seating capac-



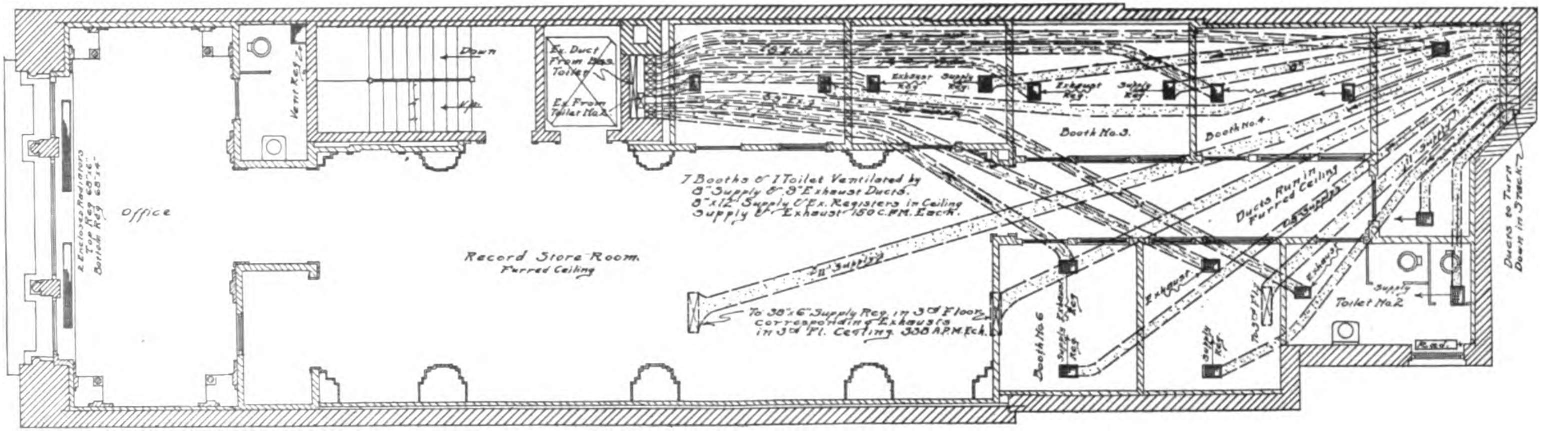
·BASEMENT - PLAN·

ARRANGEMENT OF AIR SUPPLY AND EXHAUST SYSTEMS, EDISON PHONOGRAPH SHOP, NEW YORK.



·FIRST-FLOOR-PLAN·

FIRST FLOOR PLAN, EDISON PHONOGRAPH SHOP, SHOWING CONCERT HALL.



·SECOND-FLOOR-PLAN·

ARRANGEMENT OF AIR SUPPLY AND EXHAUST DUCTS CONNECTING TO INDIVIDUAL BOOTHS, EDISON PHONOGRAPH SHOP.

ity of 65. The air supply was based on a purity of 8 parts of carbon dioxide to 1000 parts of air, with an assumed purity of 4.5 parts for outside air. Each occupant will exhale about 0.01 cu. ft. CO_2 per minute, so to maintain this purity $0.01 \div (0.0008-0.00045) = 28.6$, or 30 cu. ft. per minute will be required. Accordingly 1950 C. M. F. was allowed for this room on both the supply and exhaust systems. Under usual conditions this amount of air will give more than 30 C. F. M. per person, as this amount is based on the hall being filled to its capacity, and ordinarily will give greater purity than that stated above.

For the booths, it was not possible to determine the exact number of occupants, so the small booths on the second floor, which are 7½ ft. x 10½ ft. x 9½ ft., were given a five-minute air change or 150 C. F. M. This amount will maintain the standard of purity set for the concert hall when an operator and four customers are occupying the same booth. A six-minute air change was given the third floor booths, which are 12 ft. × 18 ft. x 9 ft., and at that rate 330 C. F. M. each is required. This amount was also allowed for on the exhaust system, thus giving 30 C. F. M. to each ten customers and one operator.

The second floor toilet, which is of practically the same size as the smaller booths, was given a supply of 125 C. F. M. and an exhaust of 150 C. F. M.; the exhaust being made greater than the supply in order to obviate any possibility of foul air leaking into the corridors. For the same reason the basement toilet was given an exhaust of 250 C. F. M. with only a grille in the lower panel of the door for a supply.

In the case of the first floor store, which is treated hereafter, the heat required and the temperature of the air supply determined the amount of air as the number of occupants is small and constantly changing.

FIGURING TEMPERATURE OF AIR SUPPLY.

The temperature of the air supply from the main heater was determined by the temperature loss from the air in travelling from the fan to the second floor ceiling, where the air is distributed to the various rooms. As but one of the booths has a wall exposure, which is very small, the temperature of the air supply at the register was set at 70° F., thus making the required air temperature at the fan 70°, plus the drop in temperature of the air while passing from the fan to the second floor ceiling. The main supply stack has an exposed wall area of 224 sq. ft. and an air velocity of 700 ft. The transmission factor for the usual 12-in. unfurred brick wall is 0.318 B. T. U. per degree difference of temperature. If the velocity of the circulating air in a room is assumed to be 80 ft. per minute down the wall and the transmission factor varies as the square root of the velocity of the air, this gives a transmission factor for the outside wall of the duct of 0.9 B. T. U. per hour per degree difference in temperature, when the velocity of the air is 700 ft. per minute. From this it was determined that the duct would radiate 224 sq. ft. x 0.9 B. T. U. x 75° = 15,000 B. T. U. per hour.

To supply this radiation it was necessary to raise the temperature of the 2200 cu. ft. of air 6° above the temperature desired or to 76° F. as may be seen from the following:

$$\frac{15{,}000 \text{ B.T.U.}}{2200 \text{ F.P.M.} \times 60 \text{ min.} \times 0.02} = 5.7 \text{ or } 6^\circ$$

As booth No. 5, on the second floor, has an exposed wall area of 80 sq. ft., its temperature was made slightly under that of the other rooms, but not enough to warrant extra radiation. To heat to 70° F. the main concert hall, which has 800 sq. ft. of exposed wall and 21 sq. ft. of exposed door, requires 16,000 B. T. U. per hour. As stated above the air supply to this room is 1900 C. F. M. and when

$$\text{heated } \frac{1600 \text{ B. T. U.}}{1915 \text{ C.F.M.} \times 60 \text{ min.} \times 0.02} = 7^\circ$$

above the room temperature supplies the necessary heat.

As the temperature of the air supply is only 76°, this makes the room temperature slightly over 69° when the other rooms are at 70°.

SEPARATE INDIRECT RADIATOR TO HEAT MAIN STORE.

As previously mentioned a screw pin indirect radiator was installed at the point shown in the boiler room to supply the necessary heat to the main store, which has 280 sq. ft. of glass and 300 sq. ft. of exposed wall, equivalent to 60,000 B. T. U. per hour. Assuming a maximum temperature of 120° F. for the air supply

$$\frac{60{,}000 \text{ B. T. U.}}{60 \times 0.02 \times (120° - 70°)} = 1{,}000 \text{ C.F.M.}$$

required to supply the heat. The coefficient of transmission for the school pin radiator was taken as equal to 5 B. T. U. per degree difference of temperature per hour with an air velocity of 500 ft. per minute through the radiator. The difference in the average temperature of air and steam being 112° F., this made the heat delivered, per square foot of radiator, 560 B. T. U. per hour. Of the required temperature rise above 70° F., 6° was supplied by the main heater, making the necessary heat to be delivered to the air by the indirect, 52,800 B. T. U. To deliver this amount of heat 94 sq. ft. of surface was required, so the nearest size, 100 sq. ft. was installed. This heater was connected on a two-pipe system with an air by-pass the full size of the supply duct.

DESIGN OF APPARATUS FOR HEATING THE AIR SUPPLY.

To heat the air supply, Vento heaters were used with an air velocity of 1,000 ft. per minute through the stacks. With this velocity, the total amount of air to be heated, 52,000 cu. ft. per minute, required 5.2 sq. ft. of free area. From the Vento tables, it was determined that with standard 5-in. spacing, three stacks would heat the air from 0° to 86° F., a temperature which is higher than is required but which will be necessary later if an air washer is installed as contemplated.

A three-stack heater, with nine sections per stack, having 291 sq. ft. of heating surface, was installed at the point indicated. Each stack of the heater was valved separately so that by using these valves in connection with the air by-pass any desired air temperature may be obtained.

For determining the size of such heaters, various formulas have been advanced, but the tables compiled by the different heater companies have been found much more convenient for practical application.

DUCTS.

For the air distribution, a combination of the trunk duct system and the branch duct system was used, with a main supply duct in the basement and main supply and exhaust stacks branching to the various registers in furred ceilings. Under ordinary conditions the trunk duct system would have been used throughout but for ventilating the sound-proof booths it was not feasible to make the branch ducts short as they would serve to transmit sound through the main duct from one booth to the others. To obviate any such tendency all branch ducts were constructed of No. 22 gauge galvanized iron and covered with ⅛-in. asbestos mill board, wired on and run separately to the main stacks. All the large ducts in the basement were constructed of No. 24 gauge galvanized iron and braced with angle irons.

The main vertical supply and exhaust stacks were formed in the building construction, with the branch supply ducts turning down and the branch exhaust ducts up, in their respective stacks. In the case of the toilet exhausts, the branches were carried up separately to the fan to prevent odors from being carried from the toilets through the branch ducts to the booths, when the fan was not running.

The velocity in the small ducts was taken at 500 ft. per minute for the supply and 400 ft. per minute for the exhaust. The velocity in the main supply duct was made 1,000 ft. per minute and 700 ft. per minute in the vertical supply stack, while 900 ft. per minute was necessary in the vertical exhaust stack, because of the building construction.

For the supply system the greatest friction was from the fan through the small ducts to booth No. 1. This included 45 ft. of 8-in. pipe, with three elbows, at 500 ft. velocity; a 36 ft. ver-

tical stack at 700 ft. velocity and 24 ft. of horizontal duct, with three elbows, at 1,000 ft. velocity, which is equivalent to a friction head of 0.15 oz. static pressure. This friction is usually taken from tables, but where tables are not available the formula, $P=\frac{KSV}{A}$ is used where

P = pressure loss in ounces per square inch.

S = friction surface in square feet.

A = area of duct in square inches, regardless of shape.

V = velocity in feet per second.

K = 0.00012 and 0.00022 for galvanized and brick ducts, respectively.

For elbows the radius of the throat was made equal to the width of the duct. When this is true the friction of an elbow is equivalent to a straight pipe of the same diameter with a length equal to ten times the diameter of the elbow. According to Vento tables, the friction of the air at a velocity of 1,000 ft. per minute through the heater is equal to 0.1 oz. per square inch and the friction in the fresh air intake is equal to 0.035 oz. per square inch, making the total friction for the fan to overcome equal to 0.28 ounces per square inch.

Deflectors or dampers were set in all branch ducts so that the air supply might be regulated. Because of the higher velocity in the exhaust stack the irregularity of its walls and a slight leakage into the exhaust duct, the friction in the exhaust system was found to be a little higher than that of the supply system, although the two systems were designed to have the same friction. This was overcome by slightly increasing the speed of the fan.

The supply and exhaust fans have wheel diameters of 30 in. with their speeds set at 266 and 300 R. P. M., respectively. The supply fan is located at the point shown in the basement plan, while the exhaust fan is set in an air-tight pent house on the roof, directly over the vertical exhaust stack, to discharge onto the roof through a weather hood. The control of the exhaust fan is located in the basement with an ammeter in the main circuit, as required by the Fire Underwriters, where a motor is not visible from the starting box.

In zero weather the main heater will condense 1.84 lbs. of steam per hour per square foot, which is equivalent to 1.84x291 sq. ft. x 961 B. T. U.=520,000 B. T. U. per hour for the entire heater. The indirect in the boiler room will require 52,800 B. T. U. per hour, while the 660 sq. ft. of direct radiation will radiate 184,800 B. T. U. per hour, making a total of 757,600 B. T. U. per hour. Adding 10% for radiation from mains, etc., this brings the total to 833,260 B. T. U. per hour to be supplied by the boiler.

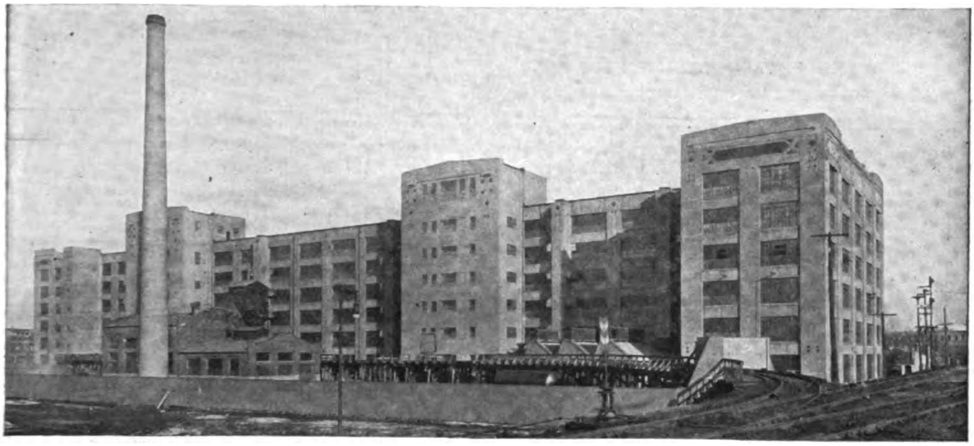
The hot water heater, which was designed to heat 100 gal. of water per hour from 50° to 180° F., requires 105,000 B. T. U., thus making the total load on the boiler 938,260 B. T. U. per hour, which is equivalent to 28.3 H. P. To supply this load a 30 H. P. horizontal, portable, fire tube boiler was installed, the rating being based on 10 sq. ft. of heating surface per horse power.

NEED OF AIR WASHER APPARENT.

Originally an air washer was contemplated which required a higher supply fan speed than that of the fan installed. On account of the extra cost of the air washer it was omitted and the fan controller changed to reduce the fan speed to conform to the new friction head. The dry air, with more or less dust which has been blown into the building, has caused quite a little damage to the interior wood decorations and the installation of an air washer is under consideration at the present time.

The installation has been operating during the present winter and has just been passed as meeting all the heating and ventilating requirements specified and mentioned above.

The work was installed under the direction of Shape and Bready, architects, and J. F. Musselman, consulting engineer, New York.



PLANT OF THE EXCELSIOR MOTOR & MANUFACTURING CO., CHICAGO.

A Factory Building Equipped With Outside Air Ducts

PLANT OF THE EXCELSIOR MOTOR AND MANUFACTURING COMPANY, CHICAGO.

In the new plant of the Excelsior Motor and Manufacturing Company at Chicago, designed by John Ahlschlager Son & Co., of that city, there are some unique features of design, of which the lighting, heating and ventilating equipment is not the least. The plant is situated on Lawndale Avenue, extending the full depth of the block from Cortland Street to the C. M. & St. P. tracks, and is six stories high with a main building 80x576 feet and an extension at one end of 50x50 feet. Connected with the plant there is a powerhouse containing two 600-horsepower boilers and two direct-connected Corliss engine driven main generating sets with auxiliaries, brick stack and coal handling equipment, the arrangement of all of which is shown in one of the accompanying photographs.

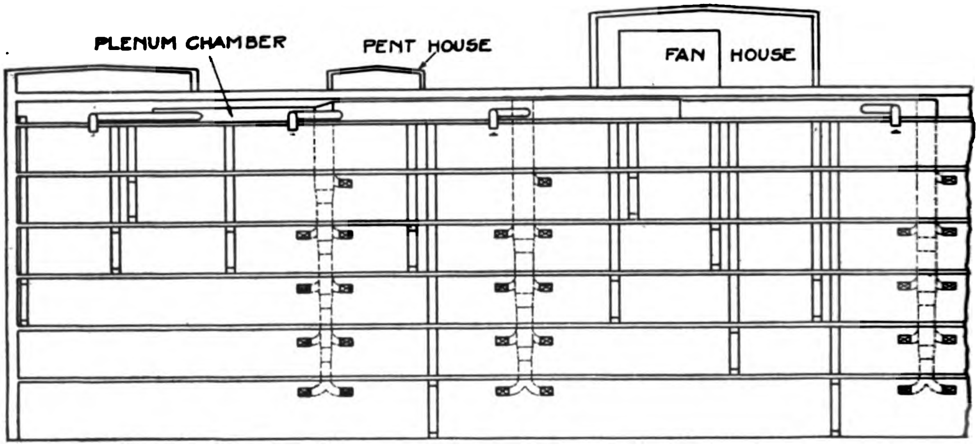
LARGE PERCENTAGE OF GLASS AREA.

The building is a monolithic structure of reinforced concrete in skeleton form with solid steel sash extending from column to column and from girder to girder. This method, as far as the engineers have been able to learn, made it possible to allow a larger per cent. of glass area to floor area than any building on record. The total glass area is 78½ per cent. of the outside walls. The plant will be devoted to the manufacture of motorcycles, the two lower floors being used for the repair and machine shops, the third floor for polishing, the fourth floor for assembling, while for the present the fifth and sixth floors will be used for storage.

AIR DUCTS CARRIED DOWN ON OUTSIDE OF BUILDING.

The owners' instructions were to maintain in the building operating conditions with respect to temperature and humidity that would promote the best efficiency, and it has proven the truth of the new economic principle "that which is best for the workmen, is best for the employer." The heating, ventilating and air washing equipment is in two units at the roof level, each consisting of one No. 15 double width Niagara Conoidal fan, belt-driven from a 50-horsepower variable speed motor, heating coils and Carrier air washers equipped with automatic humidity control. Each unit has a normal capacity of 144,000 cu. ft. of air per minute, affording an average air change of four times per hour.

The space between the roof and the sixth floor ceiling is used as a return plenum chamber. Through this are carried the supply ducts from the apparatus as shown in the plan of plenum chamber. These supply ducts except for the sixth floor, which is taken care of by branch pipes extending down through the ceiling, are carried down the outside of the building to the first floor by seven main



CROSS SECTION OF END OF BUILDING, PLANT OF EXCELSIOR MOTOR & MANUFACTURING CO.

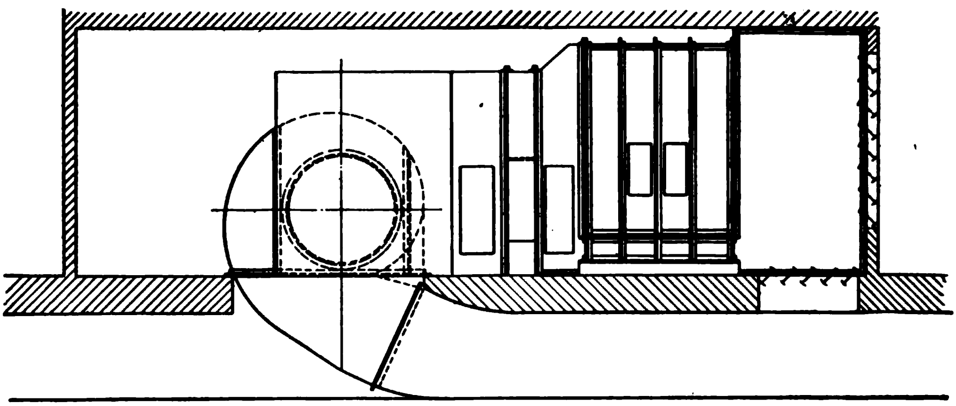
stand-pipes, which are of heavy gauge galvanized iron. These stand-pipes with their branched outlets are entirely enclosed and protected by concrete stacks having 6-inch walls and air space between them. The supply of air is introduced along the west side of the building near the ceiling levels. All outlets have hand control dampers and diffuser plates to deflect the air uniformly at from 800 to 900 feet entering velocity.

ARRANGEMENTS FOR RECIRCULATION.

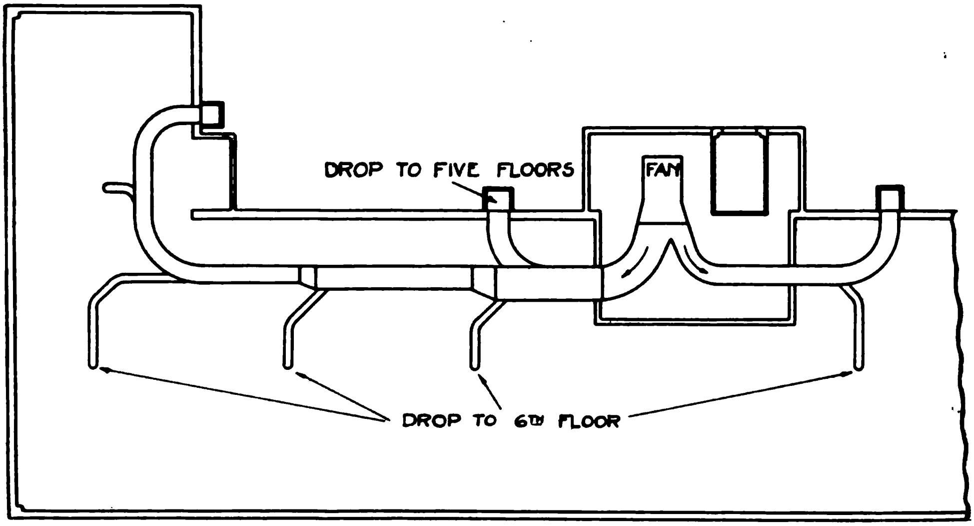
To provide ventilation and, if desirable, recirculation of air from each floor independently, vertical galvanized iron air ducts are uniformly spaced around the entire building on each side of the columns, which project 12 inches into the room. The ducts are 12x20 inches, and it will be seen from the sectional elevation that separate ducts are carried to each floor with openings at floor and ceiling which are finished with wire screens and dampers. This arrangement permits the air to be exhausted from either floor or ceiling level, depending on the season and whether cooling or heating is desired. The tops of these exhaust ducts extend 18 inches above the sixth floor ceiling into the return air chamber, and each is fitted with an automatic fire damper. By this method there is no possibility of fire communicating from floor to floor.

AIR WASHERS SPECIALLY DESIGNED FOR COOLING.

The air washers are Carrier Type "B" machines, which are designed specially for cooling, and throughout the warm weather are designed to reduce the temperature of the air to that of the outside wet bulb thermometer, which in Chicago rarely exceeds 76 degrees F., and is usually much lower, even through the



ELEVATION OF APPARATUS IN FAN ROOM ON ROOF.

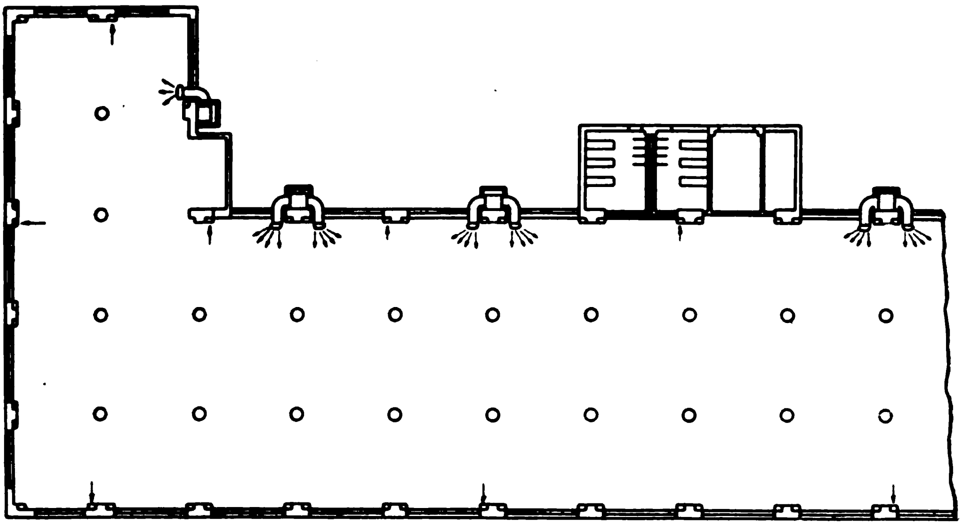


PLAN OF PLENUM CHAMBER, PLANT OF EXCELSIOR MOTOR & MFG. CO.

hottest periods. As outdoor air exclusively will be used in the summer, the temperature of the air delivered to the workrooms in that case will be that of the outside wet bulb temperature plus the temperature rise due to friction and the transmision of external heat, which it has been carefuly calculated will not exceed 3 degrees.

In addition to the main sprays, flooding nozzles extend the full width of the air washers, and are located directly above the first four corrugations of the eliminators. These flooding nozzles keep a constant flow of water over the surface of the plates, keping them clean and maintaining a high washing efficiency without any perceptible increase of moisture content of the air.

Considerable weight was given in the selection of the air washers to this feature, and to the unusually large amount of washing surface provided. There are two banks of spray nozzles, which may be operated separately if desired, and the spray water is recirculated by direct-connected 6-inch centrifugal pumps, each of the double suction type with hori-



TYPICAL FLOOR PLAN. PLANT OF EXCELSIOR MOTOR & MFG. CO.

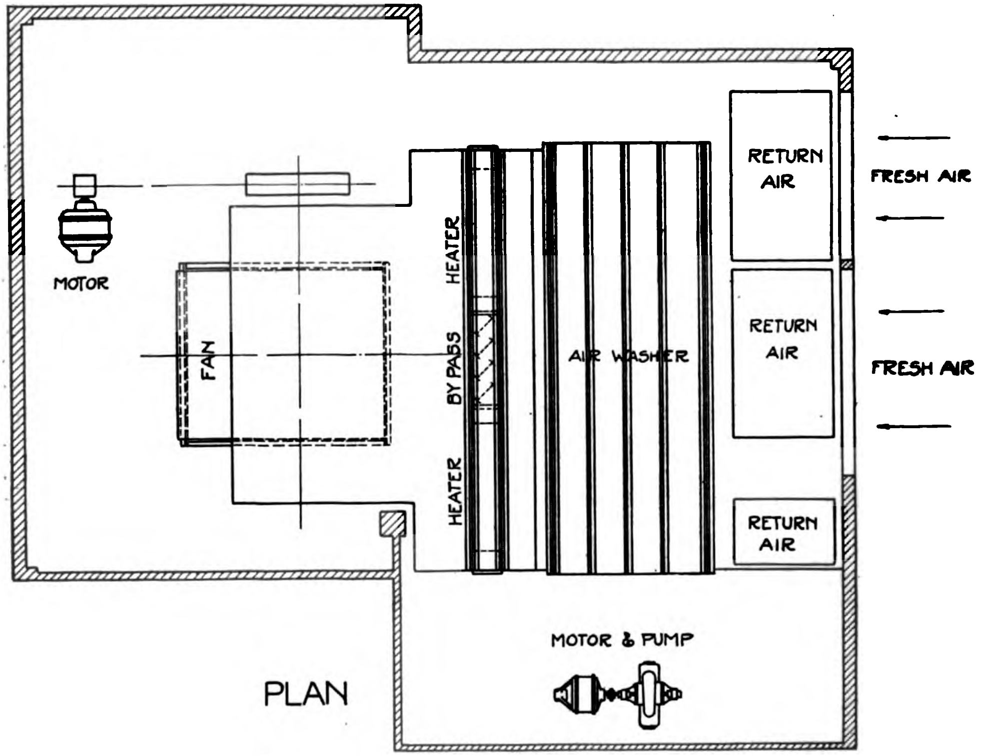
zontally split shells, made by the Buffalo Steam Pump Company and driven by 20-horsepower motors. Each air washer is 25 feet wide and 13 ft. 2 in. high, requiring the circulation of 42,500 gals. of spray water per hour.

The coils are cast-iron Vento radiation placed betwen air washers and fans, and two stacks high with by-pass areas for use in summer. As direct radiation is provided for heating, the indirect stacks are proportioned so as to raise the air temperature from 40 to 85 degrees, the air being heated to 40 degres under extreme conditions by means of the Carrier automatic humidity control. In moderate weather the use of direct radiation has been found unnecesary.

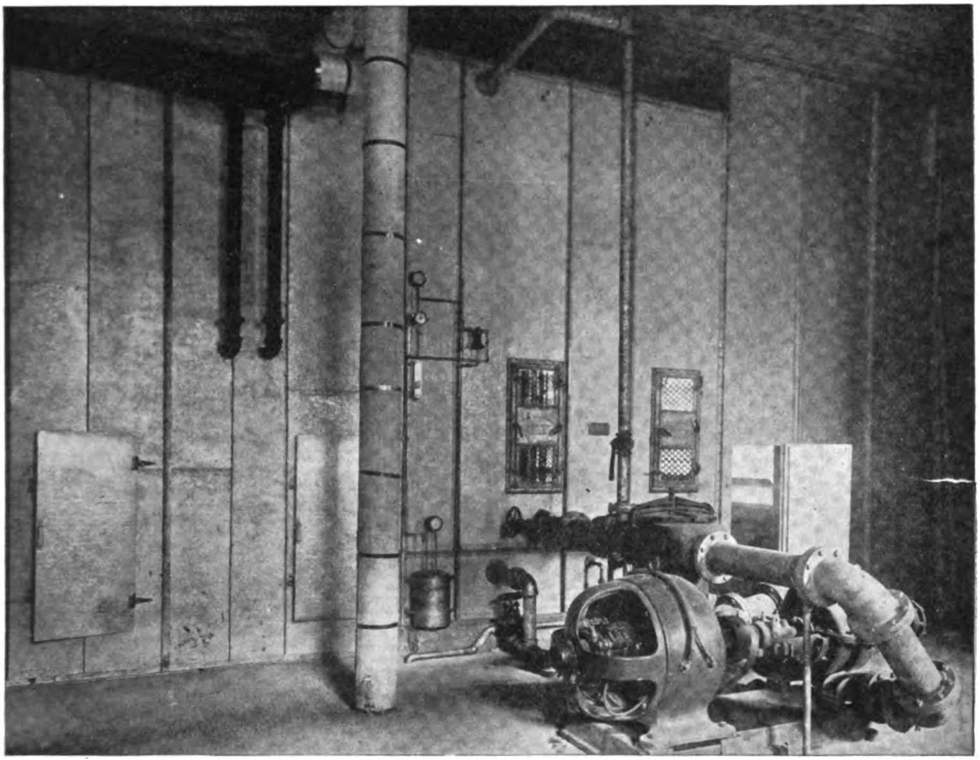
UNIQUE METHOD OF REGULATING HUMIDITY AND TEMPERATURE.

The operation of the humidity and temperature regulation is distinctly new, and takes advantage of the fact that the ventilating system will supply an amount of air very greatly in execess of the standard requirement of 30 cu. ft. per minute per occupant, also that any part of this air which is recirculated will first be thoroughly washed and cooled. This partial recirculation takes place whenever the outside wet bulb temperature is below 40 degrees F. in the following manner:

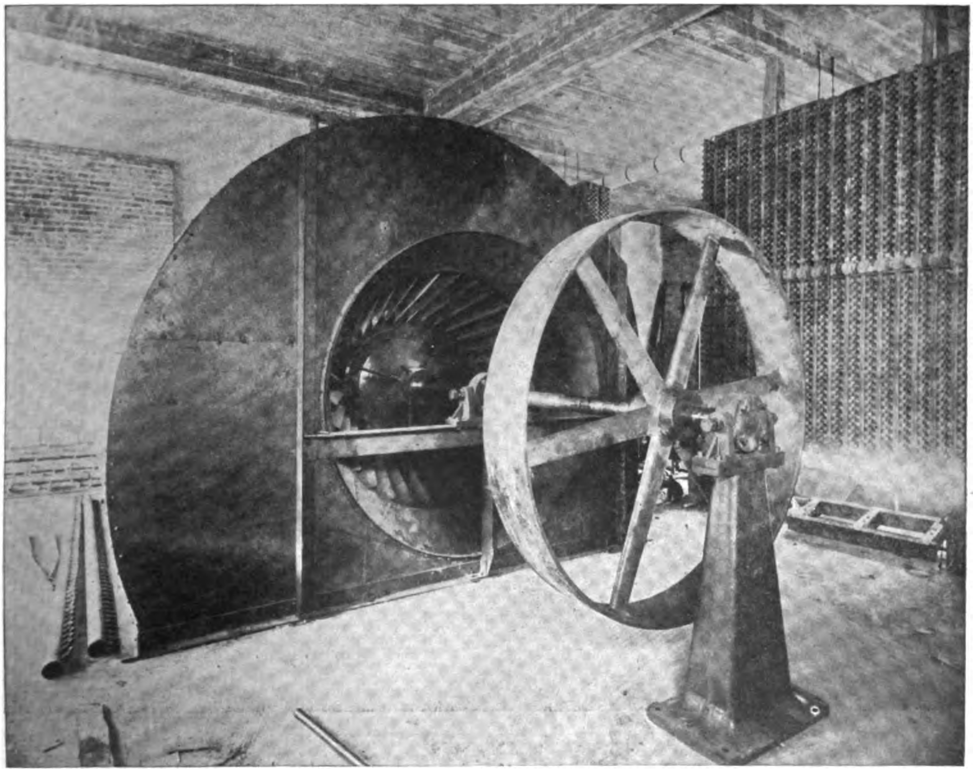
The two pent houses on the roofs are skeleton structures, as shown in the small photograph, with louvre dampers on all four sides operated by air motors in the same manner as the fresh and return air dampers in the fan houses. These are all linked together, automatically controlled by Carrier graduated action thermostats, using compressed air as the motive power for their operation, and this control is adjusted so that the correct proportion of fresh and return air is taken into the apparatus for maintaining a constant saturated temperature or dewpoint leaving the air washer. The louvre dampers in the pent houses and return air dampers in the floors of the fan houses both open directly into the return plenum chamber and operate in a reverse direction, so that, for instance, when the outside temperature drops, the control calls for more warm air, the



PLAN OF FAN AND HEATER APPARATUS, PLANT OF EXCELSIOR MOTOR & MFG. CO.

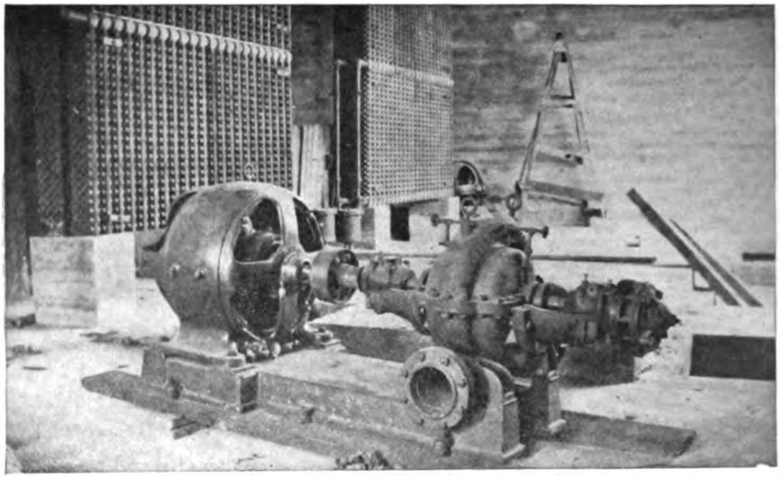


ONE OF THE AIR WASHERS ERECTED, PLANT OF EXCELSIOR MOTOR & MFG. CO.



FAN AND HEATER UNDER ERECTION, PLANT OF EXCELSIOR MOTOR & MFG. CO.

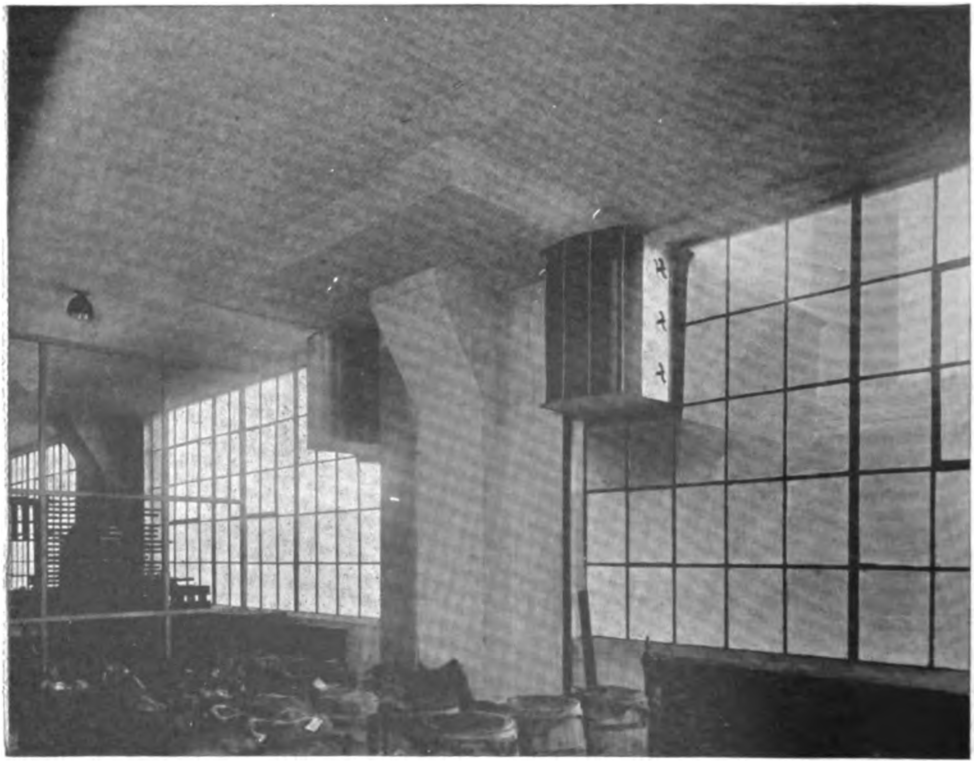
fresh air dampers and the pent house dampers partly close, while the return matic control of the entering temperature makes them unnecessary.



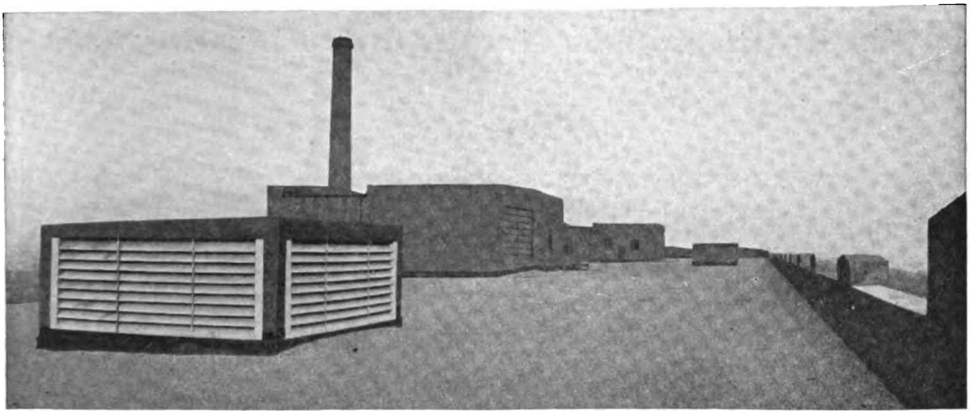
ONE OF THE SPRAY PUMPS, SHOWING VENTO HEATERS IN BACKGROUND.

air dampers open up a sufficient amount to permit more warm air from the building to enter the air washers. No tempering coils are provided, as the auto-

There is found to be a great deal of economy in this method of regulating the humidity and temperature, since in extreme weather the use of tempering



AIR INTAKES AND DIFFUSERS, PLANT OF EXCELSIOR MOTOR & MFG. CO.
(See branch connections outside window.)



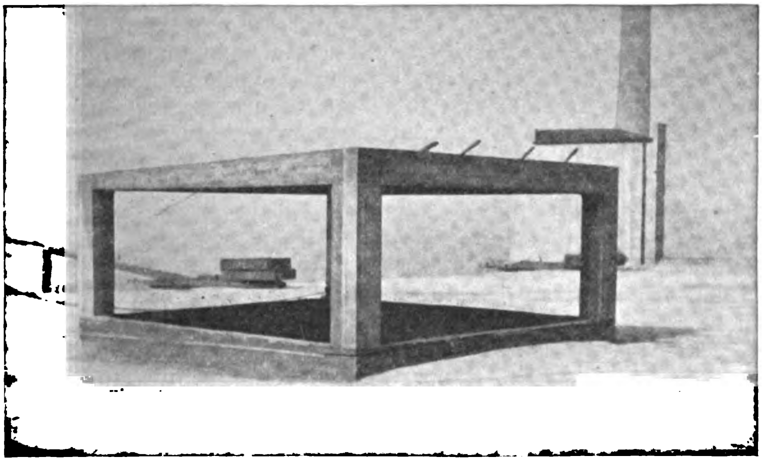
ROOF, PLANT OF EXCELSIOR MOTOR & MFG. CO., SHOWING PENT HOUSES AND FAN HOUSES WITH AUTOMATIC DAMPERS.

coils instead of return air would require 350 horsepower of steam additional. The saving due to omission of the coils, additional boiler power, and cost of installation is several times the cost of the automatic humidity regulation.

The use of the outside concrete ducts for a building of this size and construction is novel, but the calculations for heat radiation, and the precautions taken to prevent excessive losses, have proven entirely successful, while the freedom from interior obstruction which this arrangement affords is of much greater value than the extra cost of the ducts.

The addition of exhaust ducts and the double system of registers at floor and ceiling is another feature which, though not yet tested through a summer season, will be of inestimable value as a means of insuring good ventilation and thorough distribution of air. In winter the registers at the floor will be open, so as to induce a downward movement of air and prevent stratification, while in summer rapid circulation and escape of warm air will be insured by closing the floor registers and opening those at the ceiling.

It may be added that this plant operating with the system as here described, although not yet fully organized or equipped, is turning out 150 motorcycles per day. It is designed to accommodate a working force eventually of 2,500 to 3,000 men.



SKELETON OF PENT HOUSE, WITHOUT DAMPERS.

The Vento radiation was furnished by the American Radiator Company of Chicago, the fans by the Buffalo Forge Company of Buffalo, N. Y., and the air washers by the Carrier Air Conditioning Company of New York.

The Relation of the Architect and the Engineer

II.

By D. D. Kimball.

President, American Society of Heating and Ventilating Engineers;
Member, New York State Commission on Ventilation.

(Read before the Pittsburgh Chapter American Institute of Architects, and here first published.)

An incidental, but very great, advantage of the employment of the engineer lies in the assurance of safety in undertaking separate contracts for the building and its equipment. I am well aware of the great diversity of opinion among architects as to the wisdom of separate contracts. A survey of this problem leads me to the conclusion that the separation of the building and equipment contracts is rapidly and deservedly coming to the front. Three States already have laws calling for the separation of contracts on all State, county or city work and others will doubtless rapidly follow. This will have its effect on the general practice.

The attitude of the general contractors in opposition to such course is well known. It is only natural that they should use any legitimate means to increase the amounts of their contracts. It is customary for them to state that the total cost of the work is no greater in case of the general contract. But the heating, electrical, plumbing and other trade contractors will make just as low prices to an owner as they will to a general contractor. In fact many of the best contractors will make lower prices to an owner than to a general contractor, for they have become thoroughly annoyed at the customary practice of the general contractors of shopping the bids of subcontractors. They realize that after submitting the first bid they will be called upon for a reduction in the amount of their bid after the general contractor has his contract, and for this they provide by making their first bid high. Thus the owner pays a higher price for the equipment than would otherwise be the case.

But recently a large heating contractor told an architect in my presence that he would always bid 5% less to an owner than to a general contractor. In another case a plumbing contractor offered to reduce a bid already made by 3% if the owner would contract direct rather than through a general contractor.

The claim that the general contractor can secure a lower price because of the volume of his business is a fallacy. The equipment contractors prefer to bid direct and the advantages to him of so doing warrant a lower price. The volume of business available to the equipment contractors is the same in either case.

A general contractor may state that he places a lower percentage of profit on the work if he includes within his price the amounts of these sub-contracts, but this is not believed to be a fact, for the remaining portion of the general contract is for the most part a grouping of subcontracts and competition can well be depended upon to keep down the percentage of profit on the part of the general contractor. In any case what slight difference the general contractor can make in his percentage of profit will still leave an advantage in favor of the separate contracts.

A frequent objection made by the architect to separate contracts is that there is a difficulty in placing responsibility for the progress of the work, one contractor blaming the other in case of delays. Surely the architect and engineers are equal to the solution of these difficulties, involving only the placing of responsibility for each detail of the work upon the proper contractor.

I am thoroughly familiar with both methods of procedure and I never have found an instance of serious difficulty in conducting work by means of separate contracts. There is a very decided advantage in being able to deal directly with, and in being able to control, the

sub-contractors. There is also a material saving in the amount of labor in administering the details of the work, the prevailing opinion to the contrary notwithstanding.

In the case of the general contract all instructions have to go from the architect to the general contractor, thence to the sub-contractor, the reply goes from the sub-contractor to the general contractor and thence to the architect, while in the case of separate contracts the architect can deal directly with every contractor with a material saving in time.

The indirection of communication in the case of a general contract will be found to have a serious effect on the cost of extra work.

There is also the advantage of that direct choice of sub-contractors which insures the selection of only the highest grade contractors, those whom the architect and owner know and those in whom they have confidence.

Another reason for the higher subcontractors' prices when the sub-contracts are made a part of the general contract is the delay to which the sub-contractor is subjected in receiving his payments. In relatively few cases does the general contractor turn over to the subcontractor his proper proportion of payment received. In effect, therefore, the sub-contractor is largely financing the general contractor and he naturally charges for this service.

But the architect may say "if you propose to divorce the heating, electrical and plumbing work from the general contract why not the steel work, fireproofing, plastering and other portions of the structure." A reasonable answer to this would be that while a building without the heating, lighting and plumbing would not be a comfortable or convenient building to occupy, it would still be structurally complete and the relation of the sub-contractors having to do with the carpentry, plumbing, plastering, etc., are much more intimate than in the case of the sub-contractors for the heating, lighting, plumbing and general building trades sub-contractors. In other words, there is a line at which an entirely reasonable separation can be made without injury to anybody and with advantage to the owner and architect.

In several cities the heating, plumbing or electrical contractors' associations have passed resolutions declining to figure work for general contractors. In such cases the general contractors are not able to secure sub-bids from the best heating, electrical and plumbing contractors.

WHEN ENGINEERING SERVICES SHOULD BE EMPLOYED.

It is granted, without argument, that heating, plumbing, electrical and similar work in small buildings, such as small houses, police and fire stations, small stores and small office buildings are not these upon which consulting engineering services are required, for the reason that any architect's office should include in its staff someone sufficiently well acquainted with the details of these systems to enable the architect to prepare a satisfactory set of plans and specifications for this simple work.

However, all work involving intricate problems, including such buildings as hospitals, hotels, schools, theatres, large store and office buildings, mercantile establishments, large residences, and any building involving power, refrigerating, pumping or other complicated plants should be the subject of engineering advice.

Any work the preparation of plans and specifications for which is beyond the ability of the personnel of the architect's staff, independent of advice from a contractor's or manufacturer's engineer, should be consigned to the care of the independent consulting engineer.

The distinction between the two classes of buildings cannot be well based on the cost of the building for some large buildings involve very simple problems of heating, lighting and plumbing, while, in other cases, small buildings, especially hospitals, hotels and schools, involve intricate problems in the design of the equipment.

PAYMENT TO THE ENGINEER.

There is no respect in which the work of the engineer is less expensive proportionately than the work of the architect, and the education, training and experience of the engineer is quite as extensive and expensive as that of the average architect. In proportion to the amount of the fee paid to the engineer the cost

of the engineer's plans and specifications is quite as great as the cost of the plans and specifications of the architect, and the cost of the work upon which the engineer's fee is based is much smaller than the cost of the work upon which the architect's fee is based. Why, then, should not the engineer be paid as high a rate as the architect?

It is admitted that it is customary among engineers to charge a smaller fee to the architect than to the owner when the architect is to no extent reimbursed, or in effect, give to the architect a discount as a wholesale customer. This is due principally to the recognition of the fact that the architect may not be asked to pay all his fee on that part of the work given to the engineer, for as stated above, the architect is involved in considerable cost in carrying on the administration of this work. This reduction of the architect's fee is unreasonable and is but added chaos to an unscientific basis of architectural and engineering fees.

Therefore, if the architect receives 6% on a piece of work the engineer should also receive 6% upon his portion of the work, or if the architect receives 5% the engineer should also receive 5%.

Some architects are in the habit of asking owners to pay 5% or 6% extra on the cost of the engineering equipment where engineering services are employed. Others ask the owner to pay 2½% or 3%. I have discussed this matter with many architects and in the majority of cases there is an agreement of opinion that while the owner directly receives the benefit of the engineering services and may, therefore, be reasonably asked to pay the extra cost to the architect, there is no justification for asking the owner to pay a full 5% or 6% extra, for the architect is certainly saved some expense in the making of plans and specifications and supervision of the work, and he is not called upon to give of special training, experience or knowledge on this work.

If the owner pays the architect 6% on the cost of the complete structure, including the engineering equipment, and is then asked to pay 6% extra on the cost of the engineering equipment for the services of the engineer, he is somewhere paying for more than he is getting, for is it not true that not both the architect and engineer are called upon to give the same knowledge and experience or are put to the full expense of making the plans and specifications and supervising the installation of the engineering equipment? The engineer certainly is put to the full expense customary in professional services of this nature, and the architect is put to a certain but not equal expense. Therefore, a logical conclusion would seem to be that the engineer should be paid a full fee and that the architect should be paid in proportion to the expense to which he is put, plus the usual profit. Thus the owner gets full value of what he pays.

An arrangement which has many times proven satisfactory provides an extra payment of 2½% to 3% for engineering services, depending upon whether the architect's fee was 5% or 6%.

The payment of an extra 3% on the mechanical equipment of a building represents apparently an increase on the cost of the building of but three-tenths to seven-tenths of 1%, but actually the employment of the independent engineer will save much more than this in the cost of installation and in the annual cost of operation and maintenance. The use of contractor's or manufacturer's plans and specifications will assuredly mean an increased cost of installation and operation much greater than the amount of the engineer's fee.

By some it is contended that the architect's fee over the entire building should be increased sufficiently to include the cost of engineering services. The first objection to this lies in the popular, but mistaken, impression that the architect's fee is already extremely profitable and, consequently, a further general increase would be most unpopular. A second objection is that some architects would still not employ the engineer while others would employ the cheapest talent. Again, in a hospital costing $1,000,000 the entire equipment might represent 25% of the cost of the building and in a cathedral costing the same sum the equipment might cost but 5%. This difficulty would

be experienced in fixing a rule or even in determining the correct fee in an individual case.

The demand for a full extra fee on the mechanical equipment has many times led owners to separate entirely the architectural and engineering work, paying to the architect and engineer a full fee on the portion of the work assigned to each only.

There is a disposition among certain engineers to argue that the construction of a building, including foundations, structural steel, walls, floors, partitions, spacing and equipment is largely an engineering problem and that, therefore, the entire commission should be placed in the hands of an engineer who should employ an architect to add the esthetic features to the plans.

The adoption of an accepted method of procedure adhered to by all architects will materially lessen the force of such views.

ENGINEERING SERVICES IN ARCHITECTS' SCHEDULE OF CHARGES AND CONTRACTS.

The lack of uniformity in the practices of architects in these matters has befogged the entire subject and prevented altogether the enlightenment of the owner.

The schedules of fees of the American Institute of Architects provides that the owner shall pay extra for engineering fees where such services are required, but to the average owner this provision is ambiguous. It does not state the amount of such extra payment nor does it state to what class of work this rule is to be applied. Consequently some architects suffer extreme embarrassment in asking for an extra payment for engineering services, while others, and I have one particularly in mind, unhesitatingly apply this rule on practically all occasions.

Recently I have had three different experiences, all of the architects involved being members of the American Institute of Architects. In the first case I had the good fortune to be personally acquainted with five of seven members of the building committee. This gave me an unusual opportunity for this presentation of the American Institute of Architects' rule for extra payment for engineering services. I still believe that this rule could have been made effective in this case had not the selected architect volunteered to assume all of the expense of engineering services. In the second instance the president of the building committee was an intimate friend and was agreeable to paying extra for engineering services. The architect in this case volunteered to relinquish all claim to a fee on the engineering equipment so that the engineer and architect were employed and paid separately. In the third case the committee had been brought to a point where they were prepared to pay extra for engineering services when three architects volunteered to assume the expense of engineering services if they but be given the job.

In the matter of payment to the engineer there is just as little uniformity of practice.

Is there any reason why the method of payment provided for in the architects' schedule of charges should not be applied by the architect in making payments to the engineer, even to the payment of the usual proportion of the engineer's fee when the letting of the contract is delayed through no fault of the engineer, especially when the making of the plans and specifications for the engineering equipment by the engineer has been essential to the letting of the construction contract, and the architect has received his usual payment of the construction contract?

Let us consider briefly a few examples of contracts or competition programs making provision for the employment of engineering services. First we will note the admirable provision in one of New York City's architectural contracts. Of course it should have provided 6% instead of 5% to the architect and 3% extra for engineering.

"As additional and cumulative compensation, and for the employment of an engineering specialist, 2½% of the total cost of the heating and ventilating work, plumbing, electrical and refrigerating work, power plant and apparatus, appliances, appurtenances, fixtures and equipment, including such fixtures, fittings, cooking appliances and the like as may be necessary and proper to render the work, building, or structure complete and ready for service and use, will be paid."

This could have been improved by stating its evident intent that the engineer be paid 5%.

From the competition program for the New York County court house:

"When and as often as the board shall determine that the employment of engineering or other specialists is necessary for the proper performance of the work, either in the preparations of the plans and specifications or in the supervision, superintendence and direction of the erection, then the architect, at his own sole cost and expense, shall employ such engineering and other specialists for the purposes aforesaid, and in every such case such engineering or other specialists must be such as the board shall, in writing, approve."

This is wrong in that the architect is not in any degree reimbursed for the cost of engineering services.

From the competition program for the Albany court house and public buildings at Wilmington, N. J.:

"The board is to reimburse the architect the cost of the services of engineers for heating, mechanical and electrical work. The employment of engineers and their compensation shall be subject to the approval of the board."

This is too indefinite, failing to specify the amount of extra compensation.

From the competition program for a library building at Indianapolis:

"The architect is to nominate a clerk of the works and the engineers for the heating, ventilating and electrical systems of the building, and their proposed compensation having been approved by the board, the architect is, by and with the consent of the board, to appoint them."

Observe, please, the variety in these provisions. Only the first provides for the rate of compensation for engineering services. The engineer has the same reason as has the architect to desire his fee to be fixed. In as much as this is a part of the architect's fee, also to the end that all uncertainties shall be eliminated from the competition program, which is usually the basis of the architect's contract, it would seem desirable that this matter should be definitely determined.

A SUGGESTION FOR RULE COVERING EXTRA PAYMENTS FOR ENGINEERING SERVICES.

The first essential in the solution of this problem is an agreement upon some acceptable rule, the second essential is a strict adherence thereto, and the third, and perhaps the most important essential, is the enlightenment of the owner and building committees.

May I make so bold as to offer the following suggestion for a rule covering this matter?

"In connection with the heating, ventilating, plumbing, electrical, refrigerating, elevator, cooking, laundry, power plant and other mechanical equipment, the architect shall employ consulting engineers who shall, in co-operation with the architects, design, prepare plans and specifications for, and supervise the installation of the above equipment. The engineers so selected shall be subject to the approval of the owner, the rate of compensation to be paid by the architect to the engineers to be 6%, the owner hereby agreeing to pay to the architect 3% additional on that portion of the work upon which engineering services are employed. The architect shall at all times be chief in authority."

The Performance and Selection of Centrifugal Fans

DATA AND NOTES APPLYING TO BOTH STEEL PLATE AND MULTIVANE TYPES.

BY THE LATE FRANK L. BUSEY.

(*From a Paper Presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York, January* 20-22, 1915.)

Frequent reference has been made in fan work to *static pressure* and *velocity pressure,* and also the conversion from velocity to static pressure at the fan outlet. The air is delivered against a certain definite resistance of the system, due for instance to ducts and heaters, and this is termed static resistance. It is then necessary for the fan to develop a definite static pressure sufficient to overcome this resistance of the system. In addition to the *static* pressure, the air has imparted to it a certain *velocity* pressure due to its velocity on leaving the fan outlet, this velocity being dependent on the amount of air handled and on the area of the outlet.

The total energy imparted to the air is composed of the static pressure of the system and the energy of discharge corresponding to the velocity pressure, or velocity head as it is termed in hydraulics. *The total pressure is the sum of the velocity pressure at the fan outlet and the static pressure of the system,* and is the pressure upon which the performance and efficiency of the fan is usually based. In the case of an exhaust or draw through system, the static head on the fan should be taken as the difference in static pressure at the inlet and outlet of the fan, one being positive and the other negative.

DEFINITION OF STATIC AND VELOCITY PRESSURES.

The relation between static and total pressure and between static and total efficiency in fan work is not generally understood. Many engineers as well as fan builders consider only the total efficiency of a fan, even when the resistances are estimated in static pressures. The static pressure is the potential energy developed by the fan, and is the energy available for performing useful work in overcoming the frictional resistance of the system. The velocity pressure is the kinetic energy used in moving the air and is a measure of the air quantity handled, but until it is converted to static pressure is not available for overcoming resistance.

Thus it is seen that the greater the static pressure developed at the fan outlet in proportion to the velocity pressure, the more effective will be the performance of the fan in overcoming frictional resistance, and therefore the greater the *static efficiency.* Since the velocity and therefore the velocity pressure varies inversely as the area of the fan outlet, and since the sum of the static and velocity pressures are constant (being equal to the total pressure), it is evident that the larger the outlet of a fan the greater will be the static pressure developed.

FAN EFFICIENCY.

The efficiency of a fan is the ratio of the power output to the power input, or the ratio of the work done in delivering a certain amount of air against some known pressure to the work done by the engine or motor used in driving the fan. We may have two different efficiencies, either *static efficiency* or *total efficiency,* depending on whether we are considering static or total pressure. Since the total pressure is greater than the static pressure, the total efficiency is greater than the static efficiency, and for this reason the efficiency generally referred to in fan performance is based on the total pressure.

It has been seen that a high static pressure and a correspondingly high static efficiency are of vital importance in fan performance. A fan having a high total but a low static efficiency may in most cases be less desirable than another having a high static efficiency, even though the total efficiency be less than that of the first fan. Since in the majority of installations the principal work performed by the fan is in overcoming the static resistance of the system, a fan giving a high static efficiency means a

low power consumption, and at least where power is being bought it means a saving in dollars and cents.

HOW TO DETERMINE STATIC EFFICIENCY.

Although but few fan builders are accustomed to mention the static efficiency of their product, the static efficiency may be readily calculated when the ratio of static to total pressure at rated capacity of any special fan is known. Thus if the static pressure is 80 per cent. of the rated total pressure, the static efficiency will be 80 per cent. of the total efficiency. Or expressed as formulæ, the efficiencies are:

$$\text{Static eff.} = \frac{0.0001565 \times Q \times \text{static press. in inches}}{\text{H.P.}}$$

$$\text{Total eff.} = \frac{0.0001565 \times Q \times \text{total press. in inches}}{\text{H.P.}}$$

where Q equals the quantity of air in cubic feet per minute, the pressure is expressed in inches of water, and H.P. represents the horse power input.

Thus it is seen that the ratio of static to velocity pressure at the fan outlet is of the greatest importance in fan selection. This ratio varies as the square of the fan capacity, at constant speed, and bears a definite experimental relationship to the efficiency of the fan.

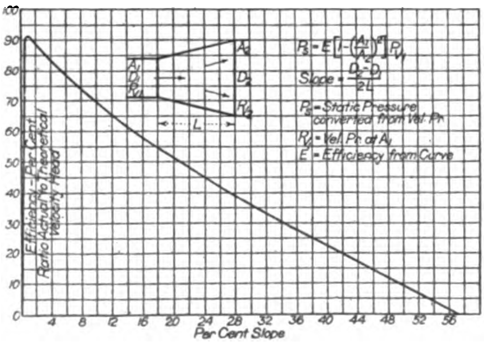


FIG. 1—EFFICIENCY OF DIVERGING NOZZLES.

As already mentioned, where the velocity and consequent velocity pressure at the fan outlet is very high, a part of this velocity pressure may be converted to static pressure and the desired ratio between the two obtained, by using a diverging cone or chimney outlet on the discharge of the fan. The efficiency of this conversion depends on the slope of the sides of the cone, and is never the full 100 per cent. That is, there is always some loss of head in converting from velocity to static pressure.

As will be noted from a study of Fig. 1, a diverging cone or nozzle, to give the maximum conversion from velocity to static pressure with the least possible loss, must be constructed with an easy slope and not with an abrupt flare. The diagram here shown indicates what may

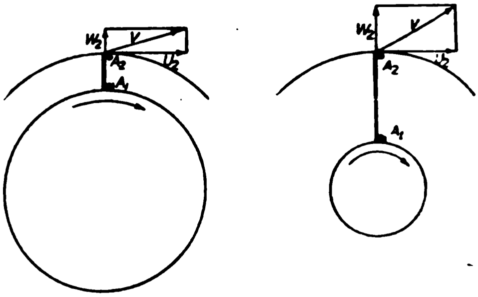


FIG. 2—EFFECT OF CENTRIFUGAL ACTION IN FAN WHEELS.

be termed the efficiency of diverging nozzles having different slopes to the sides. We note that with a 10 per cent. slope, or a slope to each side of say one inch in ten, the efficiency of conversion is 70 per cent. That is, while there will be a certain drop in velocity pressure due to the enlargement in cross-section of the pipe, only 70 per cent. of this drop will be converted to static pressure in the cone and the balance will be lost. While as high as 90 per cent. conversion may be obtained, the cone would have to be longer than is generally found practical and a cone with 10 per cent. slope gives good average results. If made with a length of twice the smaller diameter, and the area of the large end twice that of the small end, a diverging nozzle will have a slope of approximately 10 per cent.

RELATIVE PERFORMANCE OF THE STRAIGHT AND CURVED BLADES AND OF THE STEEL PLATE AND MULTIVANE TYPES OF FANS

In any centrifugal fan there are two separate and independent sources of pressure. First, pure centrifugal force

due to the rotation of an enclosed column of air. Second, the kinetic energy contained in the air by virtue of its velocity upon leaving the periphery of the fan rotor. The amount of centrifugal force imparted to the air depends largely upon the ratio of the tangential or rotational velocity of the air leaving the periphery of the rotor to the tangential or rotational velocity of the air entering the fan at the heel of the blades.

The effect of the centrifugal force of the column of air between the blades of a fan is frequently overlooked, since it is difficult to think of the air as having weight. The action of the particles of air within the fan wheel may be illustrated by the two diagrams in Fig. 2. If we consider a particle of air located at A_1 at the heel of the blade, when the wheel is rotated this particle will be thrown to the tip of the blade, and the centrifugal force will give it a certain velocity W_2. But at the same time, the particle has imparted to it a certain rotational or tangential velocity U_2. The resulting velocity V represents the force actually imparted to the particle of air as it leaves the tip of the blade. A comparison of the two figures will show why a fan with longer blades—if they are both straight—will give a greater pressure than will a short blade fan at the same speed. That is, the pressure for a given peripheral speed is increased by increasing the relative length of the blades.

The method used for overcoming this fault of the short straight blade is to make it curved. The effect of so doing is shown by the diagram Fig. 3, the effect on the velocity by curving the blades forward or backward being indicated by the parallelograms. It will be noticed that when the blade is bent forward, a pressure greater than that corresponding to the peripheral velocity is obtained. This results in the same pressure with a lower speed than would be necessary with the straight blade when using the same wheel diameter. On the other hand it is sometimes desired to direct-connect the fan to a high speed unit without developing the corresponding high pressure. This is accomplished by bending the blades backward, so obtaining a pressure less than that corresponding to the peripheral velocity.

TWO CLASSES OF CENTRIFUGAL FANS

Centrifugal fans may be roughly divided into two classes, fans having rotors with straight radial blades, and fans having rotors with blades curved with reference to their direction of rotation. Curved blade fans have quite diverse characteristics depending on whether they are curved forward or backward with reference to their direction of rotation. The mathematical theory of the radial blade fan is very completely and clearly discussed in Prof. Carpenter's book on Heating and Ventilation. The amount of total pressure developed by a straight blade fan may be

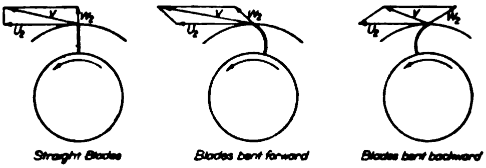


FIG. 3—RELATIVE EFFECT OF DIFFERENT SHAPED BLADES.

mathematically determined, but in the case of a curved blade fan this can only be known by means of actual tests.

The amount of pressure developed by a straight blade fan may be determined by means of the formulæ.

$$P_s = \left(\frac{U_2}{V_0}\right)^2 \left[e + (1 - R^2) - f\left(\frac{V_1}{U_2}\right)^2\right] - \left(\frac{V_2}{V_0}\right)^2$$

$$P_v = \left(\frac{V^2}{V_0}\right)^2$$

Where P_s = static presure at fan outlet.
P_v = velocity pressure at fan outlet.
V_0 = velocity corresponding to unit pressure.
V_1 = velocity of air entering fan inlet.
V_2 = velocity of air at fan outlet.
U_2 = peripheral velocity of wheel.
R = ratio inlet to wheel diam.

e and f are coefficients varying with the ratio of height to width of fan outlet.

When the flow of air through the rotor of a fan is partially obstructed the centrifugal effect in the rotor produces a compression corresponding to the centrifugal force, which is known as a static pressure. On the other hand, the kinetic energy of the air leaving the periphery of the rotor must first be converted largely into potential energy in the form of static pressure before being serviceable. This conversion from kinetic energy or velocity into potential energy or static pressure is ordinarily accomplished in the scroll formation of the fan housing. A still further conversion is often secured, where the velocity leaving the outlet is high, by means of a diverging nozzle on the outlet of the fan.

The velocity of the air leaving the tip of the blades and the corresponding velocity pressure is greatly in excess of that ordinarily required in the piping system, and at the same time the static pressure is too low. By enclosing the wheel in casing having a properly designed scroll, this velocity is reduced and a part of the velocity pressure is converted to static pressure. Since the static pressure due to the wheel will vary as the difference of the squares of the rotational velocities at the periphery and inlet, it is evident that the shorter the blade the greater must be the dependence on the scroll shaped housing to obtain the desired static pressure. For this reason the proper design of the housing is of greater importance in the case of a short blade multivane type of fan than with the older styles.

HOW STRAIGHT BLADE FANS MAY BE MADE MORE EFFICIENT THAN MULTIVANE FANS

The standard steel plate fan is essentially a straight blade fan, as compared with the later styles of short curved blade multivane type, although, as already shown, when the tip of the blades are bent either forward or backward the fan will have different characteristics from one with strictly straight blades. This fan as ordinarily built does not give as high an efficiency as the multivane type, owing to the fact that it is designed for large capacity rather than for high efficiency. But if these long blade fans are built according to special design they may be made to give greater efficiency than can be obtained from the curved short blade fans. This calls for a tall narrow fan with the inlet diameter smaller than that used on the standard fan. It may be readily shown that there is a certain diameter of inlet that will give maximum economy of operation. If the diameter is increased the loss by impact at the heel of the blades is increased as the square of the diameter, and the loss by entrance is decreased as the fourth power of the diameter. The opposite holds true in case the inlet diameter is decreased.

The proper size of the fan inlet depends on the cubic feet of air per revolution handled by the fan. It has been determined both mathematically and

TABLE I.—COMPARATIVE EFFECT OF BLAST WHEEL PROPORTIONS UPON THE EFFECT OF STRAIGHT BLADE FANS OPERATING AT THE SAME CAPACITY AND PRESSURE.

Ratio of Dia. Inlet to Dia. Wheel at Perip.	Per Cent. Relative Diameter. Wheel.	Per Cent. Relative Diameter. Inlet.	Per Cent. Relative Width.	Per Cent. Relative H.P.	Per Cent. Relative Speed.
0.700	82.0	91.9	108.9	112.3	123.0
0.650	93.2	97.5	102.5	104.0	109.5
0.625	100.0	100.0	100.0	100.0	100.0
0.600	106.9	102.6	97.5	96.7	92.7
0.550	123.5	108.8	92.1	91.0	78.2
0.500	144.9	116.6	85.9	86.8	64.5
0.450	170.8	123.0	81.3	83.4	53.3
0.400	206.5	132.4	75.5	80.0	43.1
0.350	255.0	142.8	70.1	77.5	34.6

experimentally that the most efficient diameter of inlet is given by the equation

$$D_1 = C\sqrt{\frac{Q}{N}}$$

Where D_1 = inlet diameter.
Q = cu. ft. air per minute.
N = revolution per minute.

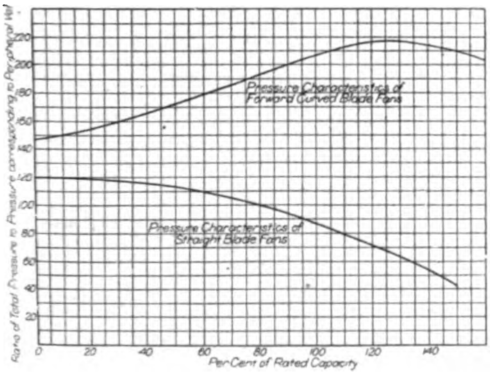


FIG. 4—PRESSURE CHARACTERISTICS AT CONSTANT SPEED.

C = is a factor determined experimentally and is practically a constant for all ratios of inlet diameter to wheel diameter.

It may be noted from Table I that the essential factor in the design of straight blade fans is the diameter of the inlet, and that the smaller the inlet as compared to the diameter of the wheel, the greater will be the efficiency attained, but at a sacrifice in capacity. This table is based on the assumption that a value of 62.5 per cent. for the above ratio be used to represent the average standard fan, and the other figures show the comparative values for other ratios. It will be seen from the second and fourth columns that the height of the fan increases rapidly while the width decreases. This means, then, that these special high efficiency fans are tall and narrow, which naturally makes them more expensive than the ordinary commercial steel plate fan.

These special tall narrow fans are frequently used for induced draft work, partly because the narrow wheel makes a shorter overhang on the fan bearing, and partly because they may be operated at lower speed and are therefore more suitable for direct connection to steam engines.

It will be noted from the diagram Fig. 4, that the pressure characteristics of the fan with forward curved blades are quite different from those of a fan having straight blades. Although this peculiarity of the two types is often overlooked and perhaps not generally understood, it is nevertheless of the greatest importance and should be considered in the selection of a fan. We see that with a straight blade fan the pressure tends to build up as the load on the fan is reduced, while operating at constant speed.

Thus, if such a fan be used to supply forced draft to a boiler, and due to the thickening of the fuel bed the discharge from the fan should be throttled, the pressure will increase. This is just exactly the condition that would be desired. On the other hand, with a forward curved blade, as the air delivery is decreased the pressure would also fall off. Another case where this peculiarity

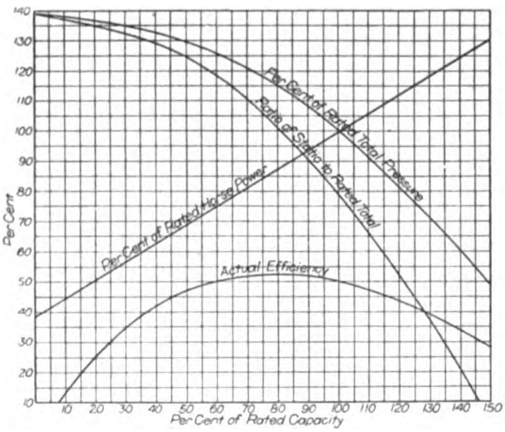


FIG. 5—PERFORMANCE CURVE OF BUFFALO PLANOIDAL STEEL PLATE BLOWERS, STRAIGHT BLADE TYPE.

is of importance is when a fan is required to operate part of the time at a considerable underload, yet a definite pressure must be maintained. For such a case the straight blade fan should be used.

The general characteristics of the

two types of fans will be shown by Figs. 5, 6 and 7. The most noticeable difference between the two is in the pressure curves and the horsepower curves. Here we have shown the characteristics of a typical straight blade fan, in which the pressure increases as the load is decreased. It will be noted in this case that the H.P. characteristics gave a straight line, this being a peculiarity of the straight blade fan.

Fig. 7 shows the actual test results obtained from a fan with forward curved blades. In making a shop or laboratory test the most accurate results are obtained by attaching to the fan outlet a straight pipe of about thirty diameters in length, with means provided at the discharge end of attaching plates having different sizes of openings. In this way, the quantity of air handled may be

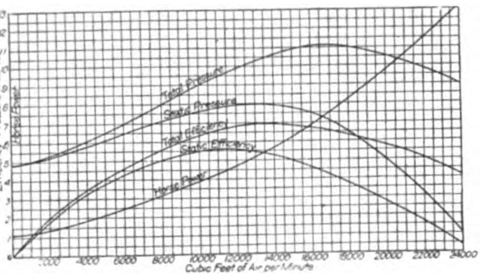


FIG. 6—TEST OF A NO. 8 NIAGARA CONOIDAL FAN. 450 R.P.M.

varied from nothing to the full capacity of the fan, and by this means the performance of the fan at different capacities may be determined. The fan is then operated at some constant speed, and by means of a Pitot tube in the discharge pipe about twenty diameters from the fan outlet the pressures developed with each outlet are noted. At the same time power readings are taken in order to compute the horsepower and efficiency.

These values are then plotted and curves drawn as in Fig. 6, and by a study of these curves a certain capacity is selected as giving for the widest range of conditions the most satisfactory performance characteristics for this type of fan. This point is then termed the rating of this size of fan at the speed used. By redrawing these curves as shown in Fig. 7, in per cent. of the rated performance, the characteristics

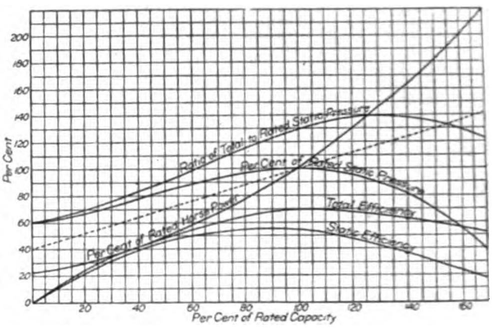


FIG. 7—PERFORMANCE CURVE OF BUFFALO NIAGARA CONOIDAL FAN, FORWARD CURVED BLADE TYPE.

of this style of fan for any size may be readily found for any other than the rated capacity. The ordinary fan capacity tables are evolved from the values selected at point of rating.

It will be seen from this diagram, Fig. 7, that the pressure curves for a fan with forward curved blades are entirely different from the ones already shown in Fig. 5 for the straight blade type. At no load the total pressure is 47 per cent. of the rated, while with the straight blade fan the ratio is 140 per cent. The dotted line is the H.P. curve reproduced from the diagram of a straight blade fan. The most important point to be noted here is the great difference btween these two lines beyond the point of 100 per cent. capacity. We see how rapidly the horsepower goes up with an overload, with the total pressure also increasing. This explains why any fan

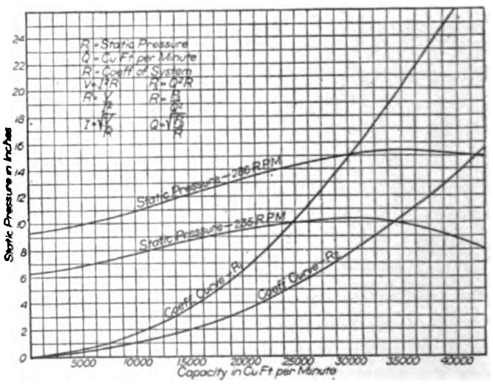


FIG. 8—RELATIVE PERFORMANCE OF A NO. 10 NIAGARA CONOIDAL FAN.

with short forward curved blades is so liable to overload the motor, if by any chance the static resistance of the system should happen to be less than estimated. For instance, if a fan should draw its supply of air through the by-pass during the summer, instead of through the heater, as ordinarily designed, the resistance of the system may be decreased sufficiently to increase the quantity of air handled as much as 15 per cent. The increase in power consumption for a straight blade fan would be about 8 per cent., but with a forward curved blade such as here considered the increase in power would be about 19 per cent.

The concluding portion of Mr. Busey's paper, which is devoted to fan selection, including an explanation of the new fan tables, giving the fan performance at other than its rated point, will be presented next month.

District Heating

By S. Morgan Bushnell and Fred B. Orr.

CONDENSATION METERS.

This series of articles commenced in the January, 1915, *issue.*)

The idea of measuring the condensation from heating systems to determine the steam consumption was a very radical departure from previous practice, and did not take concrete form until 1904 in which year a patent was granted to John D. Walsh on the device which has since been manufactured under the trade name —Simplex condensation meter. The introduction of this meter marked an important step in the evolution of the industry and while it cannot be said to have been a cure-all for the weaknesses apparent in the operation of district heating systems, yet the decade intervening since the idea first took root has furnished ample justification for the experiment.

The advent of the condensation meter ushered in an era of prosperity for many heating companies that had been struggling along in hopeless financial difficulties, not because of improper installations, and management, but as a result of the inability to sell their product scientifically and secure adequate returns on the investment.

The first manufacturer to enter the field with a condensation meter was the American District Steam Company. Through its affiliations with extensive heating interests throughout the country this company in the capacity of engineers, operators and owners has been naturally equipped for taking the leadership when improvements of any kind are demanded. It is not at all strange that their experience prompted them to experiment on some device which would be more satisfactory as between company and consumer than was the primitive Holly steam meter; and at the same time offer an avenue of escape from the evils lurking in the various systems of flat rates.

Since it has been seen that steam meters are usually complicated, it follows that they will also be comparatively costly. It is obvious that for large companies serving hundreds of customers, the investment charges for steam meters would be enormous. Not only the first cost but also the amount of attention required and the labor of computing the meter records are factors entering into the question. For the multitude of small individual consumers, such as residences, stores and restaurants, the steam meter must be waived in favor of a much simpler method of measurement. The condensation meter has played a very important part in the steam heating industry, much more so, in fact, than the steam meter, primarily on account of the difference in cost. The condensation meter fills the requirements for a simple, accurate and inexpensive method of selling steam and, consequently, has been used almost exclusively by most companies, except in the largest cities.

Most of the present types of meters are acceptable for the purpose intended, provided every precaution is taken to install them properly. The most essential point to consider is the fact that condensation meters are not guaranteed to operate under pressure. They are essentially gravity meters in that they will not dis-

TABLE III.—CLASSIFICATION OF CONDENSATION METERS.

	Primary Element.	Secondary Element.	Name and Maker.	
Weight meters....	Dump bucket.	Gears and dials.	Simplex— American District Steam Co.	1904
			Crescent— W. H. Pearce & Co.	
Volume meters....	Revolving drum.	Gears and dials.	Tyler— Tyler Underground Heating Systems.	1914
	Revolving drum.	Gears and dial.	Detroit— Central Station Steam Co.	1906
Trap meters......	Tilt trap.	Trip counter.	Cranetilt— Crane Co.	
	Float trap.	Diaphragm counter and dial.	Trapand — J. C. Hornung.	1912

charge when there is any back pressure on the outlet or discharge line. Therefore, their use is limited to places where the following can be observed:

LIMITATIONS IN USE OF CONDENSATION METERS.

1. The returns from the radiation must pass through a steam trap of the constant or continuous flow type, to prevent sudden surges of the return water. This liability is present when pot or bucket traps are used.

2. Some method must be adopted for relieving the discharge line from the trap of any vapor which might otherwise enter the meter. Hot water vapor or air, in mixture with the condensation, has a tendency to "spin" the revolving type meter; and, due to its pressure, produces a velocity of impact on the dump type. Both of these effects lead to inaccuracy, usually over-registering. Methods of overcoming this are shown in Fig. 1.

3. The meter must have a free and unobstructed discharge to a suitable catch basin if the returns are to be wasted to the sewer, or connected to a return line, which must be under gravity or vacuum pressure.

Fig. 2 shows the Simplex condensation meter which is of the "dumping type." This meter will be found to be reasonably accurate between temperatures of 55° F. and 180° F.

The Detroit condensation meter, first put on the market about 1906, is shown in Fig. 3. Since then many of the defects present in the original designs have been eliminated successfully. The patent covering the application of the revolving drum or turbine to the measurement of fluids was issued to Hans Reisert, of Cologne, Germany, and the rights were acquired by the present manufacturers in 1907. Among several improvements added to the original instrument is one adapting the meter to vacuum return lines which is accomplished by making

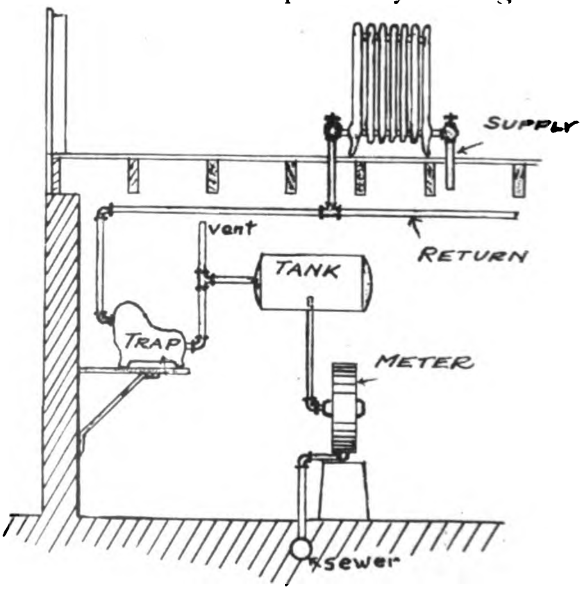


FIG. 1—METHOD OF CONNECTING CONDENSATION METERS TO PREVENT "SPINNING."

an air-tight drum casing. A suitable vacuum pot or trap must be connected ahead of the meter to prevent leakage of steam into same.

This feature does away with one of the principal difficulties in the way of a general adoption of condensation meters,

FIG. 2—VIEW SHOWING CONSTRUCTION OF SIMPLEX CONDENSATION METER.

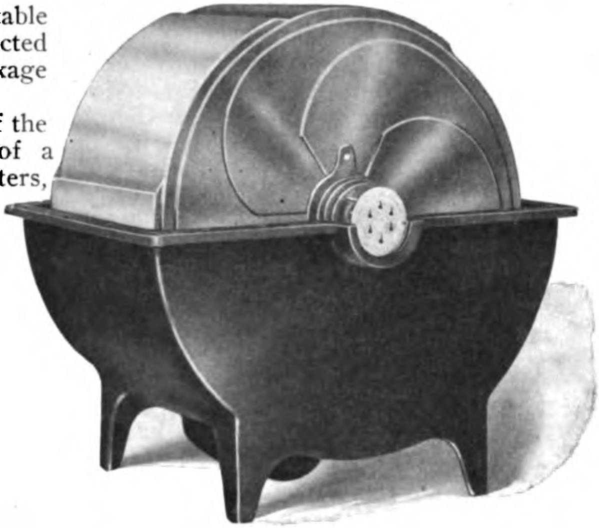


FIG. 3—DETROIT CONDENSATION METER WITH COVER REMOVED.

viz.: adaptability to vacuum systems of heating, thus obviating the necessity of wasting the returns.

CARE AND MAINTENANCE OF METERS.

If a steam heating business is to be conducted successfully, every reasonable effort must be made to preserve cordial relations between company and consumer; and the surest method of accomplishing this is to show a desire on the part of the former to maintain the metering apparatus in first-class condition. As may be inferred from the preceding discussion, if meters are to be depended upon for accuracy and reliability, much greater vigilance will be required than is the case with electric meters. This requires a thorough inspection service, combined with close scrutiny of the records of steam consumption to determine if the meter is operating satisfactorily. The causes of faulty registration may be most conveniently grouped under the following heads:

GROUP I.—METER DEFECTS.

Area Meters.—Meters may be too large for the average load.
Valve may stick or bind due to foreign matter in steam.
Orifice may become enlarged if valve pounds on seat.
Clocks and recording mechanism may be out of order on account of heat, vibration or other causes.
Pencil arm may be loose on shaft.
Meter out of vertical alignment.

Velocity meters.—Pitot-tube may be twisted out of position in the pipe.
Pitot-tube may become partially clogged by foreign particles in steam.
Leaks in piping from tubes to manometer.
Loss of mercury due to leaks.
Loose wiring connections to recording instruments.
Faulty voltage regulation for recording instruments.

Condensation meters.—Meter too small or improperly installed.
Tight bearings—need of lubrication.
Oil or other foreign matter in drums or buckets.
Spinning or sticking of drums or buckets.
Meters out of level.
Tampering by consumer.
Nozzle or spout obstructed.
Moving parts out of their proper bearings.
Register trouble—dial hands and gears loose, pinions bent, etc.

GROUP II.—SYSTEM TROUBLES.

Installation.—Vapor vents to relieve excess pressure.
Leaks in steam piping.
Leaks in return piping.
No protection against surging or flooding.
Wrong type of steam trap.
For vacuum meters a vacuum pot or trap is necessary.
Not sufficient fall to the sewer.
Not sufficient head on the inlet to secure full capacity of meter.
Sediment trap should be provided.

Operation.—Defective and leaky steam traps.
Sewer clogged up.
Condensation diverted, intentionally or otherwise.
Flooding of meter in early morning, due to returns being held up during the night.
Sediment trap filled.
Chemicals in return water may corrode parts of meter.
Temperature too high.

A study of the above emphasizes the great importance of this phase of the subject but unfortunately lack of space will not permit of a complete discussion of the points referred to. The literature to be procured from the manufacturers will call attention to the care necessary for successful operation of each individual meter, but the reader is urged to consult the "Transactions of the National District Heating Association," 1912-13-14, in which volumes a large fund of valuable data is to be found. These data have been prepared by committees apointed by the Association, and their reports, together with the discussions of same form the most authentic account of the experiences of many steam heating companies. A digest of these reports brings out the following important points:

Meters should be read as often as practicable in order that any defect may be immediately noted and rectified. It is not sufficient to follow the policy of the electric companies, where meters are read monthly. Much more attention is necessary.

Meters should be tested at least once each year and oftener, if erratic records have been obtained.

Much of the trouble is wrongly charged to meters since it may be the result of defects with the system of piping.

Where meters are not used in the summer season they should be protected against corrosion by being properly drained and painted.

Meters are more liable to under-register than otherwise, therefore the expense of maintaining them in good condition is in the interest of the company no less than the consumer.

GENERAL CONCLUSIONS.

It might be thought within the scope of this article to differentiate more closely as to the relative accuracy, and reliability of the different meters which have been described, but in view of the fact that the actual development of the leading makes of meters, has covered only a very few years and practically all of them are now undergoing refinement in various degrees, it is obviously unfair to

pronounce final judgment upon the question.

In general those manufacturers who recognize the paramount necessity of calibration are most likely to produce a device which can be relied upon to fill the requirements. Calibration is the key note of the art; and although we have covered at some length the theoretical principles involved and found that the various formulas could be applied with fair approximation to practical results, yet commercial requirements demand some assurance that the instrument will have been thoroughly tested under somewhat similar conditions to those for which it is to be used. A considerable part of the cost of steam flow meters is due to the expense of calibration but from this there is no escape. With this done, the steam meter may be considered as an instrument of convenience and practical utility, although in the present state of development it perhaps lacks many of the elements necessary for universal adoption.

There are few, if any, decisions which prescribe the maximum allowable error for steam companies in their dealings with the public. After considering all the facts, it would seem that commercial steam service should be supplied on the basis of an allowable variation of from 5% to 7% from the actual consumption. In other words, the companies should not be under strict legal requirements to adjust bills, unless the error has been established as lying beyond this limit, although the calibration constant of the meter should be immediately corrected according to the test results. This practice would agree with that adopted by many electric companies, although the limit of error is somewhat lower, generally 4%, which is to be expected on account of the greater ease of measuring electricity.

With reference to condensation meters, it has been seen that it requires only attention to the details of installation to procure uniform results and place these devices on a par with electric meters, as regards simplicity and precision. When choosing between the different meters now on the market it is well to rely upon the evidence to be procured from those steam companies which have experimented upon all the various types. The selection of a meter should be governed by its general reliability and expense of maintenance; as well as upon its accuracy and initial cost.

The drawback connected with condensation meters is the possibility of not receiving all the returns from the system. These may be diverted in many ways by unscrupulous customers, or through leaky piping which often escapes inspection. Frequently, it is necessary to supply steam for open jets in restaurants and industrial plants and it is impossible of course to meter the steam used for these purposes by the condensation method. Nor can these meters be used where any steam pumps are operated, unless some method is adopted of condensing all the exhaust steam. Thus it is seen that the utility of this type of device is confined within certain limits which prevent its universal adoption as a substitute for the steam meter, although it will probably never be supplanted for small consumers of steam.

The ideal meter, perhaps, is one which will measure the rate of flow of steam as it enters the consumers premises and will automatically integrate the quantity in a way similar to that which prevails in the measurement of other domestic utilities—gas, water and electricity. Such a device should be very simple in construction so as to keep the cost within reasonable limits and confine the number of parts to a minimum. The recording feature should be retained, as it furnishes indisputable evidence in case bills are questioned. It is of course, desirable that the fluctuations in pressure be compensated by some simple method. If these points were incorporated into an instrument the scientific conduct of district heating would be an assured fact.

Attempts have been made to build satisfactory instruments for the purpose of metering the heat supplied in terms of British thermal units, instead of the prevailing custom—pounds of steam. Such a device is urgently needed by hot-water heating companies, as by this method the present compulsory use of flat rates would then be unnecessary.

Next month the authors will discuss the relation between steam and electric loads in buildings and the sale of heating service as an adjunct to central station service in large buildings.

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ONCE in a while the editor's mail contains a letter with a distinct jolt in it and this is the case with the following, taken from a recent communication:

"It is of course appreciated that your readers are, for the most part, master steam fitters and heating engineers and that your advertisers are, for the most part, manufacturers of steam and hot water heating apparatus, and that it is, therefore, directly to your interest to bring out particularly the high cost of electric heat as compared with systems using materials made by your advertisers and installed by your readers. However, the truth of the matter will appear regardless of whatever stand your journal assumes as to electric heat and my belief is that you can ill afford to take a stand against electric heating. Your readers are, and wish to become, interested in the best, regardless of your interests, and your advertisers will ultimately be the very ones to manufacture such specialties as are required in the installation of electric heating systems."

The phrase that appeals to us most in the foregoing is that "the truth of the matter will appear regardless of whatever stand your journal assumes.". Our correspondent is on solid ground here and we believe his statement literally. The fact is that while the course of progress, especially in engineering matters, may be impeded for a time. experience has shown that "the truth will out." It must be admitted that many of the most cherished fallacies in connection with heating work have been a long time a-dying, such as the greater comparative value of exhaust over live steam for heating purposes, and the economy of ashes as a fuel, but gradually we are emerging to the upper levels.

However, the jolt in the letter quoted lies in the charge that we are opposing the development of electric heating. We think we understand what our correspondent means. It is that we and, by implication, the heating profession, are not ready to give to electric heating the consideration it deserves. We have been accustomed so long to look upon it as a visionary proposition from a commercial standpoint that we have been inclined to overlook its merits. This may be true enough, but the fact remains that outside of certain favored localities, the most impressive feature of electric heating is its high cost.

The point made by our correspondent regarding the bearing of the interests of the advertisers on the advertising policy of a journal is "important, if true." One of the striking advantages that may be possessed by the independent trade journal is its absolute freedom from such influences. Fortunately, this happy condition was one of our birth-rights and was never so firmly cherished as at present.

Recirculation of Air for Schools

EDITOR HEATING AND VENTILATING MAGAZINE:

In reference to an admirable article entitled, "Recirculation of Air for Schools," with accompanying tables, by Ira N. Evans, which you published in THE HEATING AND VENTILATING MAGAZINE for June, 1914, I wish to advise that the following are instances of errors in the article. These errors, when carried out through the computations, affect materially the final results as given in Table IV:

Table II, Column I, sixth line, change 24 to 21.

Table II, Column D, seventh line, change 2.5 to 0.025.

Table II, Column J, seventh line, change 35 to 37.

Table II, Column K, seventh line change 1080 to 1088.

Table II, Column P, seventh line, change 14708 to 8436.

In regard to power for operating the air washer, the efficiency is given as 46% on page 50, but figured as 50% in Table II.

Table III, top of table, right hand side, 4 grains moisture, 50° to 67° F. is given as 4165 B. T. U. This should be changed to 416.5 B. T. U.

Table III, top of table, left hand side, vapor from breath is given at 1.46 cu. ft. This is rather low. The weight of water vapor, 0.00115 lbs., is given for 67° F. This should be for 90°, the temperature of the breath. (See Sturtevant's "Heating and Ventilation," page 23.) The total B. T. U. vapor should be for 90° F., and not for 67° F.

Table III, Column O, the constant 4.02 should be 3.845, if 0.45 is used as the specific heat of water vapor.

Table III, Column S, this does not appear to state (at the top of the column) the formula as figured by the author.

Table III, Column F, seventh line, change 14708 to 25255.

How is the amount of water wasted determined as being equal to the volume of CO_2 produced? See page 52, right hand column, at bottom of page.

T. W. REYNOLDS.

New York, March, 1915.

REPLY BY IRA N. EVANS.

I wish to compliment your correspondent who discovered the error in my article, as it shows more than ordinary discernment and analytical power to follow a mathematical discussion of this length with intelligence. If more readers would go into these details with care it would do more than anything else to improve the quality of technical literature.

The author had some difficulty in resurrecting the details of his own effort after six or eight months. One of the errors noted by your correspondent is so glaring as to be easily apparent, and the fact that it has not been noted heretofore would seem to show that we do too little study and are apt to take most published results for granted, or else ignore them, if they do not coincide with our opinions.

The efficiency is taken as 46% in the heat loss and figures, but 50% was stated in the table. It will be correct if 46% is stated in the table. It matters little in practice, as the variation would be greater.

In Table II, Column I, sixth line, 24 to 21 is a proper correction, reducing Column M by 688 lbs., making a difference of 1.1 cents in the result; or the cost of moisture is $0.523 instead of $0.534.

Referring to Table II, Column D, seventh line, this is correct, as Column D is headed percentages and 0.025 is 2.5%.

In Table II, Column J, seventh line, 35 to 37 is correct, but as this figure was not used, it does not change the results.

In Table II, Columns K and P, these errors do not matter, as it will be noticed that 1080 and 3648 (Cols. K-O) are crossed out and are not used, as the air was taken from out-of-doors during this period and the total amount of moisture was required for the air in any case. The heat of the room and pupils was more than sufficient to supply losses and raise the temperature, and, therefore, was not considered. This was intentional; 14,708 should be, however, 14,710 B. T. U., which is too small a difference to consider.

Referring to Table III, top of the page, right hand side, there is a mistake here in the decimal point. This is a serious error, but does not change the conclusions. The writer, however, has followed the discussion through, making the corrections in Tables III and IV, which are reproduced herewith in corrected form. It makes the proposition of recirculating the air and using the steam, with a portion of outdoor air for cooling, the best. The impurities in the air in this case are only partially removed to the extent of the air supplied from out-of-doors.

In Table III, Column O, the correction in the constant would not amount to anything, as it is only the heat required to raise the temperature of vapor and could have been neglected.

Heat Required for Condensation of Moisture from Pupils
Water Vapor from Skin · 24 Hours 2 lbs. per Pupil
$\frac{2}{24}$ x 40 = 3.333 lbs per Hour
Vapor from Breath. 1.46 Cu Ft .00115 lbs x 40 · .0673 lbs
.0673 lbs + 3.333 = 3.4 lbs. per Hour
Total BTU Vapor 67°F 1090 Less BTU Liquid 50-18 = 1072
3.4 lbs x 1072 = 3650 BTU   275 BTU x 40 = 11000 BTU

TABLE III

4- ALL AIR RECIRCULATED - COOLING BY WATER

5-AIR PARTLY RECIRULATED - COOLING BY OUTSIDE AIR

ROOM 67° F ; RELATIVE HUMIDITY 50% ; DEW POINT 50° F.

.6 Cu.Ft. x 40 Pupils = 24 Cu Ft CO_2 per Hour
24 Cu Ft Oxygen Vitiated x 5 = 120 Cu Ft Air per Hour to replace this amount.
BTU For Heating or Cooling 1600 Cu Ft Dry Air 50° to 67°F = 1824 x 17° = 31000 BTU
4 Grains Moisture 50 to 67°F
13.7 x 4 x (1089 BTU - 1081.4) = 416.5 "
31416.5 BTU

Outside Temperature Periods Degrees F.	Hours Each Period	Proportion Heat Loss	Percentage Heat Loss	BTU Loss per Hour Each Period	Total BTU per Hour Required Each Period	Total B.T.U per Period and Season	BTU for Power in Excess of Heating per Hour	Total B.T.U for Power in Excess of Heating per Season	Total B.T.U for Cooling Required per Season
A	B	C	D	E	F	G	H	I	J
				43500 BTU x COL. D	31416.5 ÷ 11000 BTU + COL. E	COL F x COL. B	35100 BTU - COL. F	COL. H x COL B	31416 + 3650 BTU x COL B
0-10°	5	62/80	77.5	33712	54128	270 640	872	4860	175 333
10°-20°	27	52/80	65	28275	48691	1314,657	6409	173,043	946 796
20°-30°	110	42/80	58.5	22873	43289	4761 790	11811	1289210	3857,315
30°-40°	270	32/80	40	17400	37816	10,210,320	17284	4666680	9467955
40°-50°	190	22/80	22.6	12000	32416	6159040	22684	4,309,960	6662635
50°-60°	232	12/80	15	6525	26841	6 250,312	28159	6532888	8,135,428
60°-70°	400	2/80	2.5	~~1000~~	14708	5883200	40392	16,156,800	——
TOTAL	1234					34,849,959		33,142,441	29,245,462

Outside Temperature Periods Degrees F.	Cooling Effect of 1000 Cu.Ft per Minute of Outside Air — B.T.U. per Hour: Raise in Temperature to 50 Degrees F.	Relative Humidity Entering Air	Grains Moisture per Cu Ft Entering Air	Grains to be Added per Cu Ft Air	BTU to Raise Temperature Vapor Entering Air	BTU to Evaporate Moisture from Water 50° F	BTU Required for Dry Air	Total B T U to Raise 1000 Cu Ft per Minute to 50 Deg F	Cu Ft Air per Minute to Reduce Heat to 50°
A	K	L	M	N	O	P	Q	R	S
		%		4 - COL M	4.02 COL K COL M	1063 BTU x 8.56 x COL. N	COL. K x 1140 BTU	COL. O + COL. P + COL. Q	36066 [illegible]
0-10°	45°	60	.25	3.75	45	34125	51300	85470	326
10°-20°	35°	60	.50	3.50	70	31850	39900	71820	374
20°-30°	25°	60	1.00	3.00	100	27300	28500	55900	450
30°-40°	15°	50	1.25	2.75	75	25025	17100	42200	
40°-50°	5°	50	1.75	2.25	35	20475	5700	26208	
50°-60°									
60°-70°									
TOTAL									

Outside Temperature Periods Degrees F.	Percentage of Air From Outside	Percentage of Air Recirculated	Water Required to Remove CO_2 from Recirculated Air	B.T.U. for Heating per Season: Last 2 Periods Table II Col Q	B.T.U. for Power in Excess of Heating Air Washer	BTU for Power in Excess of Heating Steam for Humidity	Lbs. Water for Vapor for Out-door Air
A	T	U	V	W	X	Y	Z
	COL S + 1600	1 - COL T	24 Cu Ft x COL. U x COL. B	COL. G AND COL. Q TABLE II	COL. I AND COL. R TABLE II	43800 BTU - COL F x COL B COL R TABLE II	COL M TABLE II x COL T - 3.4 x COL B COL M TABLE
0-10°	204	796	96	270640			35
10°-20°	234	766	496	1314657	173043		211
20°-30°	281	719	1897	4761790	1289210		893
30°-40°	342	658	4269	10,210320	4666680	1,453,680	3417
40°-50°	466	544	2480	6159040	4309960	2,048,960	2040
50°-60°				9207848	3575350	814,552	4880
60°-70°				5883200	16,156,800	11369800	5600
TOTAL			9238	37807,495	30,185,903	15,686,892	17076

All Air Recirculated - Cooling By Water with Air Washer

Heating Fuel $\frac{34849959 \text{ BTU}}{9 \times 2000 \times 970 \text{ BTU}}$ = 1.996 Tons Coal @ $4 - $7.984

Excess Fuel Power $\frac{33142441 \text{ BTU}}{9 \times 2000 \times 970 \text{ BTU}}$ = 1.9 Tons Coal @ $4 - $7.60

Water for Cooling $\frac{29245462 \text{ BTU}}{10 \times 62.5 \text{ lbs} \times 1000}$ = 46.8 M Cu Ft @ $1 - $46.80

Power without Air Washer 740.4 KWH @ 5¢ $37.02
" with " " 944 KWH @ 5¢ $47.20

Air Partially Recirculated Cooling by Outside Air

Heating Fuel $\frac{37807495 \text{ BTU}}{9 \times 2000 \times 970 \text{ BTU}}$ = 2.165 Tons Coal @ $4 $8.66

Excess Fuel Power, Air Washer $\frac{30185903 \text{ BTU}}{9 \times 2000 \text{ lbs} \times 970 \text{ BTU}}$ = 1.73 Tons Coal @ $4 - $6.92

Water Wasted Removing CO_2 $\frac{9238 \text{ Cu Ft}}{1000 \text{ Cu ft}}$ = 9.24 M Cu ft @ $1. $9.24

Using Steam for Vapor No Air Washer

Excess Fuel for Power $\frac{15686992 \text{ BTU}}{9 \times 2000 \times 970 \text{ BTU}}$ = .9 Tons Coal @ $4 $3.60

Water for Vapor $\frac{1076 \text{ lbs}}{62.5 \times 1000}$ = .273 M. Cu ft @ $1 $.273

CORRECTED FORM OF TABLE III.

Regarding Table III, Column S, your critic is correct in regard to the formula, which is not completely stated. The heat required to raise 1,600 cu. ft. of air per minute, with moisture, from 50° to 67° is given as (31416.5 + 3650) = 35066. This involves the error of the decimal point. Column R is for 1,000 ft. per minute and 1,000 should be stated in the formula. If we required a mixture at 50°, with the initial temperature at 67°, we would have to add

$$\frac{35066}{1600} + \frac{\text{Col. R}}{1000}$$

divided into 35066, and this would give the air displaced in cubic feet, allowing for the cooling effect of the outside air and the reduction in heat, due to displacing the air.

Referring to Table III, Column F, seventh line, this should be the same as Table II. Outdoor air is used entirely and only the heat to evaporate the moisture will be required. The heat from the pupils cannot be used to evaporate the water when not recirculating air, as it has to be done in the fan room before the air enters the class room.

Chas. H. Hughes, 82 Beaver Street, New York, naval architect and marine engineer, is compiling a handbook containing practical data on ship design and construction for shipping men. He writes that catalogues and other literature on heating and ventilating apparatus, suitable for marine purposes, would be appreciated from the readers of THE HEATING AND VENTILATING MAGAZINE.

Horizontal Air Currents in Ventilation.

The proper distribution and circulation of air in a room constitutes what I regard as the real problem that the ventilating engineer has to solve, if solved it can be. It is certain that, if we are called on to ventilate a room in such a way that every individual is conscious of even a slight horizontal circulation of the air, many of our preconceived notions in this direction must fall to the ground. To begin with, as Mr. Barker pointed out in his lecture, to produce such a circulation the whole cross-sectional area of the room should be taken as the basis of circulation of the volume of air to be supplied, and the resulting figures are sufficient to indicate that such a proposition, although no doubt, under certain conditions, quite feasible, is, to all intents and purposes, outside the range of practicability, as apart from the prohibitive cost of the installation and subsequent upkeep, the introduction of such enormous volumes of air, in such a way as to secure uniformity of movement, would present great difficulties. Especially is this the case if we regard disturbing influences, such as the opening of doors and windows, the movements of the occupants and the air eddies caused by obstructions, such as furniture, or columns, galleries and other architectural features. However excellent the idea may be in the abstract, I think the figures quoted by Mr. Barker go to show that it is somewhat Utopian in character.—*H. Hearing before the Institution (British) of Heating and Ventilating Engineers.*

TABLE IV

COMPARATIVE COSTS PER CLASS ROOM

	METHOD OF OPERATION	Number of Table	Fuel for Heating	Water for Humidity and Cooling	Excess Fuel for Power over Heating	Outside Current for Power @ 5¢ per KWH	Cost of Water and Fuel for Heating Cooling	Cost of Fuel and Water for Heating Power	Cost of Outside Current Fuel Heating Cooling	Amount per Class Room for Interest and Depreciation on Isolated Plant
			A	B	C	D	E A + B	F A+B+C	G A+B+D	H G − F
1	ALL OUT DOOR AIR ROOM 70° NO HUMIDITY	I	$11.28	$——	$4.86	$37.02	$11.28	$16.14	$48.30	$32.16
2	ALL OUT DOOR AIR ROOM 67° 50% HUMIDITY SUPPLIED BY AIR WASHER	II	17.80	.523	4.52	47.20	18 323	22843	65.523	42.68
3	ALL OUT DOOR AIR ROOM 67° 50% HUMIDITY SUPPLIED BY STEAM VAPOR	II	17.80	.523	2.80	37.02	18.323	21 123	55343	34 22
4	RECIRCULATION TO 60° 70° OUTSIDE COOLING BY WATER USING AIR WASHER	III	7 89	46 80	7 60	47.20	5478	62 38	101 98	3960
5	PARTIAL RECIRCULATION COOLING BY OUTSIDE AIR USING AIR WASHER	III	8.66	9.24	6.92	47.20	1790	2482	65 10	40 28
6	PARTIAL RECIRCULATION COOLING BY OUTSIDE AIR HUMIDITY SUPPLIED BY STEAM	III	8 66	.273	3 60	37.02	8 93	12 53	4595	33 42

CORRECTED FORM OF TABLE IV.

Cause of Excessive Humidity in Gas-Heated Rooms.

During the combustion of gas the hydrogen, either free or as a hydrocarbon, combines with oxygen of the air to form water. With the average manufactured gas the quantity of water thus formed amounts to about forty pounds for each thousand cubic feet of gas burned. So if the products of combustion are cooled below 212 degrees Fahrenheit, the moisture will be perceptible and, even a source of much annoyance.

This may explain the humidity often noticeable in rooms where the gas-heaters are not flue-connected.

This formation of water vapor occurs whenever gas is burned regardless of the kind of burner, and precautions should be taken either to keep the products at a temperature above the condensing point or to provide means for disposing of the condensed water whenever gas is burned in such a quantity that the condensation may be an annoyance. When gas room-heaters are used as auxiliaries to other sources of heat and burned for short periods, the water vapor formed is generally not sufficient to cause annoyance.—*George S. Barrows before The American Society of Heating and Ventilating Engineers.*

Further Discussion of "Engine Condensation."

Since presenting Perry West's discussion on "Engine Condensation" in the last issue, Mr. West has contributed the following note, which is supplementary to the matter published last month. This, as well as his previous discussion, is based on the belief that there is a much too generally mistaken idea that the work of admission in a steam cylinder is done at the expense of condensation in the cylinder feed, and that the negative work during exhaust re-evaporates some of the cylinder feed;

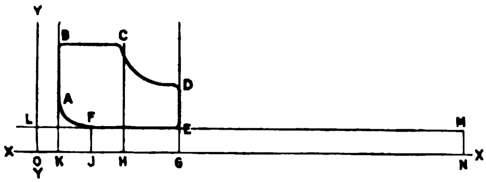


DIAGRAM ILLUSTRATING CONDENSATION OF STEAM IN ENGINE CYLINDER.

whereas, Mr. West considers that the only factors which are involved in the condensation in the cylinder feed at exhaust are the work of expansion and the work of compression.

Referring to the diagram, which is supplementary to that presented in the last issue, attention is called to the fact that in the practical condensation of this steam under a constant pressure, such as might maintain on heating systems, there are certain factors which enter, as follows: If the release pressure is above the exhaust pressure, the steam will expand along the line DEM and do work in dispelling the exhaust steam against this pressure. This, of course, takes work out of the exhaust and causes a corresponding condensation. The area LMNO will then represent the volume of steam remaining at this pressure.

Next, in order to maintain this constant pressure against the steam which is being condensed in the heating system, an amount of work must be done upon same, represented by the area FMNJ. To figure the heat available for heating under such conditions, we must, therefore, deduct the heat equivalent of the work represented by the area EMNG.

Summer Meeting to Be Held in San Francisco.

In accordance with a vote of preference on the part of the members, the summer meeting of the American Society of Heating and Ventilating Engineers will be held in San Francisco, September 16-18, 1915. These dates come just prior to the meetings of the International Engineering Congress which are to be held in San Francisco September 20-25. Already a sufficient number of members have signified their intention of going to San Francisco to assure the success of the meeting. The meeting of the International Engineering Congress, coupled with the attractions of the Panama-Pacific International Exposition, have been a potent factor in the choice of the Coast city, while the trip itself will be looked forward to as one of the most delightful features in connection with the meeting.

The railroad fare, exclusive of meals and Pullman sleeping accommodations from New York and return is $98.80, or from Chicago and return $62.50. Tickets are good for 90 days.

It is possible that a special car will be engaged for the accommodation of Eastern members.

Heating Engineers' Society to Issue Journal.

Announcement is made that the council of the society has definitely decided to publish a journal to consist largely of the papers read at the semi-annual and annual meetings. Discussions from the previous meetings will also form a part of the journal, together with reports from secretaries of chapters as to their progress and on the papers discussed at their monthly meetings. It is expected that the first number will appear in April.

Classified List of Heating Pamphlets.

A list of pamphlets on heating subjects, carefully classified, comprising papers and reports which have been presented from time to time before the heating engineers' society, has been compiled by the society and published, together with the prices at which they may be obtained. The list does not include all the papers read before the society as some are exhausted. The classification includes: Boilers for heating; car heating and ventilating; central station heating; cooling surfaces, etc.; depreciation of heating plants; drying apparatus, etc.; educational; effect of wind on heating; fans, forced blast circulation, etc.; furnace heating (hot air); foreign practice in heating and ventilating; gas heaters; heating guarantees; heating and ventilating buildings; history; humidification; miscellaneous; proportioning steam and water pipes; radiators, transmission, etc.; steam heating; time element in heating; testing heating apparatus; uniform contracts; vapor heating, etc.; ventilation, etc.; water heating; and temperature regulation.

Copies of the circular may be had by addressing the secretary, J. J. Blackmore, 29 West 39th street, New York.

Movement for an Increased Membership.

In connection with a movement to bring to the attention of heating engineers, not now members of the American Society of Heating and Ventilating Engineers, the advantages of such membership, President D. D. Kimball has sent us the following letter which we are glad to reproduce in full:

"May I, through the columns of your paper, extend an invitation to join the American Society of Heating and Ventilating Engineers to every one of the large number of gentlemen who are eligible for membership therein but are not now members. The society is growing rapidly and its meetings and papers are of increasing interest and value. The advantages of membership are such that no one identified with the practice of heating and ventilating work can afford to lose them.

"The influence of the society is growing rapidly and a larger membership only is needed to make possible the full realization of its opportunity. Last year eighty new members joined the society. Thus far this year forty-three applications have been received and we hope to gain at least one hundred and fifty new members during the year.

"Proposal blanks may be had upon application to Mr. J. J. Blackmore, secretary of the society, 29 West 39th street, New York, or from members of the society."

New Members.

The following have been elected to membership in the American Society of Heating and Ventilating Engineers: Harry A. Austin, North Tonawanda, N. Y.; Elza B. Carr, 410 Hubbell Bldg., Des Moines, Ia.; William Coler, 116 West Center Street, Akron, Ohio; M. L. Crowell, 2077 East Fourth Street, Cleveland, Ohio; St. Gem Ebert, 1123 Broadway, New York; Claude H. Eckart, 1614 Third Avenue, Seattle, Wash.; John J. Haines, 1933 West Lake Street, Chicago, Ill.; William T. Hopson, New London, Conn.; John Howatt, 710 Tribune Bldg., Chicago, Ill.; Paul F. Johnson, care of Johnson Service Co., Milwaukee, Wis.; J. W. Johnston, 343 South Dearborn Street, Chicago, Ill.; Edwin H. Lockwood, 52 Division Street, New Haven, Conn.; G. R. McGlenn, Elmira, N. Y.; David Parkhill, 107 East 29th Street, New York; John W. Winterbottom, Lock Box 45, Station A. Waterloo, Ia.; Robert Lincoln Young, 934 St. Bernard Street, Philadelphia, Pa.; William W. Rice, 1437 North Redfield Street, Philadelphia, Pa.; W. G. R. Braemer, Camden, N. J.; D. Rait Richardson, 31 West 31st Street, New York; Ivan V. Serginsky, Petrograd, Russia.

ASSOCIATE MEMBERS.

Aaron E. Carpenter, II., 64 Dey Street, New York; Henry R. Flett, 1088 King Street, West Toronto, Ont.; John F. Siegel, 101 Park Avenue, New York; Howard I. Schulz, 626 West Pratt Street, Baltimore, Md.; H. R. Watson, 110 West 40th Street, New York; Kenneth Walter Wilson, 188 Franklin Street, Boston, Mass.; A. W. Williams, 907 Brunson Bldg., Columbus, Ohio; Frederick E. W. Beebe, 123 East 27th Street, New York.

JUNIOR MEMBERS.

F. E. Thompson, 715 Spencer Street, Logansport, Ind.; Robert J. Mayer, 1691 East 86th Street, Cleveland, Ohio; Richard A. Wolff, 222 East 41st Street, New York.

New York Chapter Hears Lecture on "Wind Leakage."

Interesting data on wind leakage were presented by F. K. Davis, of the Chamberlin Metal Weather Strip Company, at the March meeting of the New York Chapter, held at the Engineering Societies Building, March 15. The address was illustrated by lantern slides.

Previous to Mr. Davis's address a report was presented by F. K. Chew for the efficiency committee of the chapter. This report was a lengthy document and was summarized by Mr. Chew. One of the principal points was a proposition for the licensing of heating and ventilating engineers. The report also took the stand that engineering work done at a figure below 5 per cent. of the cost of the installation could not be expected to be a credit to the profession. After an extended discussion it was voted that the report be printed for the benefit of the members and also referred to the council of the heating engineers' society, to be sent out to the other chapters as a tentative code of ethics for engineers. It was further decided to make the proposed code the subject for a special meeting of the New York Chapter after the other bodies had been heard from.

F. K. Davis was then introduced and gave the chapter the benefit of his experience in connection with the study of air leakage around window sash of both wood and hollow metal construction.

"The windows of a building," said Mr. Davis, "have always been an important consideration, even before the heating engineer began to find that they were no small part of his troubles. History tells us that in mediaeval times the bakers' craft in a European city was rewarded with the right to build bay windows in the houses of its members because one of them discovered an enemy's attack in time to prevent the sacking of the city. England, when sorely in need of taxes to maintain her armies, placed a tax on windows and thereby caused the middle classes to wall up such openings, showing that not only is the window problem an ancient heritage, but that we inherit tax-dodging proclivities."

Mr. Davis said that for many years window leakage was looked upon as a necessary evil and, strange to say, no attempt was made to measure it or to accurately determine its amount for nearly fifty years after the inception of modern systems of heating.

The speaker then referred to the initial experiments made by H. W. Whitten in Baltimore in 1906 and by B. S. Harrison in New York, each working independently and without knowledge of the other's work. The next tests of importance were made by Messrs. Whitten and Collamore in Detroit in 1907.

"These tests on wood windows," said Mr. Davis, "gave the first accurate or specific determinations on window leakage under variable conditions ever made and are to-day the recognized leakage data of the engineering world."

Since then a number of tests of different scope have been made, including those on hollow metal sash which are now in progress.

Like so many other new developments, the use of metal weather strips by heating contractors to reduce heat losses from buildings was at first combated and Mr. Davis paid a warm tribute to the men who first took hold of the idea of making weather stripping an adjunct of the heating installation.

Among the tables shown by Mr. Davis was the following:

Table Showing Comparative Amounts of Air at Different Wind Velocities That Pass Through a Window Sash and Through a Corresponding Unobstructed Opening.

Wind velocity, miles per hour.	Volume of air passing through sash, cu. ft. per hour.	Volume of air passing through corresponding Unobstructed Opening, cu. ft. per hour.
10.78	15.0	33.86
15.11	24.7	46.46
21.61	37.4	67.88
26.48	47.4	82.18
30.57	57.4	95.03
34.18	65.1	107.37
37.44	73.1	117.92
40.45	80.7	126.71
43.24	88.1	136.19
45.86	95.0	144.07
48.34	101.4	151.85
55.19	124.5	173.38
73.32	149.1	194.64

Mr. Davis stated that it is a practical impossibility to heat many buildings where the air leakage is uncontrolled. While the heating engineer can, with reasonable certainty, estimate the losses from walls, floors, etc., the windows and doors are more difficult to handle because the engineer has no

control over the fitting of these and he can by no means assure himself definitely what this leakage will amount to. Competitive conditions of business would prevent him from installing sufficient radiation to meet the demand. Even in old buildings the windows will shrink and swell to a great extent so that, no matter how careful the survey, such leakage can only be assumed.

"It is not exaggerating the facts," added Mr. Davis, "to state that if the specific guarantee to heat the building to 70° F. in zero weather were in every instance rigidly enforced, 90 per cent of the trade engaged in the design and installation of heating equipment would be insolvent. I make this statement upon the basis that for more than ten years one firm alone has been called upon to weatherstrip more than 500 buildings annually that were deficient in heating equipment."

Following Mr. Davis's talk, the chapter took up the recommendation of President D. D. Kimball of the society regarding a campaign to increase the society's membership. It was voted to have a special committee for this purpose to be appointed by President Timmis. A committee was also appointed to arrange for the chapter dinner in April, when the annual election will take place. This committee is composed of W. H. Driscoll, chairman; Arthur Ritter, George W. Knight, Charles E. Scott and George G. Schmidt. The candidates, as announced last month, are: For president, W. H. Driscoll and G. W. Knight; for vice-president, Arthur Ritter and P. H. Seward; for treasurer, W. J. Olvany and C. E. Scott; for secretary, F. K. Davis and R. B. Hunt; for board of governors: G. D. Farnham, C. A. Fuller, W. F. Goodnow, H. G. Issertell, W. S. Timmis and Perry West.

Illinois Chapter Discusses Boiler Room Practice in Europe and America.

The March meeting of the Illinois Chapter, held March 8 at the Great Northern Hotel, Chicago, was devoted to a lecture by William A. Blonck, president of the W. A. Blonck Co., Chicago, on "Boiler Room Practice in Power Plants in Europe and America." The professional session followed the usual chapter dinner.

Mr. Blonck was in Germany at the outbreak of the European war and gave an interesting account of the stirring scenes in connection with the mobilization of the troops. The lantern slides which accompanied his lecture included both exterior and interior views of European power plants, a noticeable feature in many cases being the unusual height of the stacks, amounting, in some cases, to 280 feet.

The speaker paid a tribute to the progress of American boiler room practice which, he said, was in advance of anything he had seen abroad. He showed a number of instruments for increasing boiler efficiency and urged their wider use in promoting economical operation in this department.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Newark Association.

At the annual meeting of the Newark (N. J.) Association of Master Steam and Hot Water Fitters, held on March 16, the following officers were elected: President, John Nellis; vice-president, John G. Kellar; treasurer, Thomas B. Cryer; secretary, Harry Geiser; executive committee (two years), W. A. Lawson; (one year) Robert Berla.

Bill to License Master Fitters in New York State.

A bill has been introduced in the New York State Legislature which, if enacted, will compel every employing steam and hot water fitter in the State to secure a certificate of competency. For this purpose the proposed law provides for an examining board of steam fitters and general power pipe fitters, whose duties will be similar to the present Examining Board of Plumbers. Each city will have its examining board, to be appointed by the mayor and to consist of two master fitters, two journeymen who have worked at the trade for ten years, and one mechanical engineer. The salary of each member of the board is placed at $10.00 per day, but members of boards in third class cities may not draw over $10.00 per month, those in second class cities, over $20.00 per month, and those in first class cities, over $40.00 per month.

Massachusetts Bill to License Steam Fitters.

According to a bill introduced in the Massachusetts Legislature, it is proposed that all corporations, associations, firms or individuals now engaged in the steam fitting or heating business in Massachusetts must secure licenses and will not be able to employ any but licensed help. The bill is now in the hands of the Committee on Mercantile Affairs. Section 1 states that "it shall be unlawful for any person, firm, association or corporation or any agent thereof, to enter into, engage in, or perform any work pertaining to the installation of any steam, hot water, vacuum, vapor or ammonia sys-

tem, or power plants, except as hereinafter provided, unless duly licensed," etc. All persons engaged in such work will be required to first make application for examination by a State Board of Examiners, to be established in accordance with the act. This board will consist of three members, one of whom must be the State inspector of heating, power and ammonia plants, one to be an employer of three years' actual experience, and the third a journeyman of at least five years' actual experience. Appointments to the board are to be made by the chief of the district police. Examinations are to be held at such times and places as in their judgment seems best.

It is further provided that the records of the board shall be accessible to the public. The fee for a master's license is placed at $5.00, and that for a journeyman at $3.00. In the event of failure to pass an examination no application for another examination shall be entertained for a period of six months. All persons, however, who can satisfy the State Board of Examiners that they have had at least five years' actual experience as journeymen shall be given a license without examination.

Penalties are provided for those who conduct their business without a license. At a public hearing March 3, W. R. Jennison, of Fitchburg, opposed the bill as a master fitter. It is understood that the journeymen favor the measure.

New Jersey Bill to Separate Contracts.

Through the initiative of Joseph A. Sprouls, chairman of the New Jersey State Association of Master Plumbers' legislative committee, a bill has been presented to the State legislature providing that where the cost of public buildings in the State shall exceed $1,000, separate plans and specifications shall be prepared "for the plumbing and gas fitting, and all work kindred thereto, and of the steam and hot water heating and ventilating apparatus, steam power plants and work kindred thereto, and electrical work," and also for the separate awarding of contracts for these portions of the work. Efforts are being made to secure the passage of the bill at the present session of the legislature.

How to Avoid Leaks in Radiators.

At a recent meeting between an architect, an owner and a building manager, at which plans for a new building were under discussion, the building manager in laying out heating equipment made this interesting statement:

"Before the radiators are installed in any building that I have anything to do with I take pains to shut off a certain form of tenant kickery by a little extra investment. I insist that each radiator be connected with a high-pressure hose and water be run through it with the sections upside down for five minutes. Then I have the radiator connected with a 30-lb. compressed air pipe and the air is forced through until a fine piece of muslin placed at the outlet pipe fails to catch any sand particles.

"It is a possible residue of core sand that I'm after. If this is allowed to remain in the pipe the grains get down into the valve seat and in a very short time I have my tenants about my ears complaining about leaky radiators. The danger of a leak starting in a radiator at night and doing a great deal of damage to floors and ceilings is abated at the very start. The extra cost of this work when the building is going up pays me handsomely, for I seldom have a report of a leak from any tenants."

A New Friction Head Slide Rule for Heating Work and Power Piping.

A new slide rule for steam heating, hot water heating and steam power piping has been designed by Charles D. Allan, mechanical engineer, 230 South La Salle street, Chicago, known as the Allan friction head slide rule. It has recently been placed on the market by The Keuffel & Esser Co., New York.

Mr. Allan states that the slide rule was suggested by the charts in Konrad Meier's work on "Mechanics of Heating and Ventilation." He noticed that only four variable quantities can be charted on logarithmic paper so that, in the case of hot water heating, a separate chart is required for each temperature drop, while in steam work a separate chart is required for each gauge pressure. As the slide rule covers this fifth variable, it naturally makes the range of information covered by the rule much geater than anything which exists in pipe tabulation.

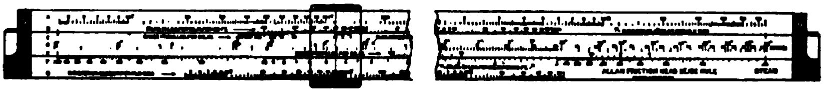
The five variable quantities in the design of steam and hot water heating and steam power piping are the volume of flow, loss of pressure due to friction, diameter of pipe, velocity of flow and the drop in temperature in hot water heating, or the gauge pressure in steam work. The range of information to be covered is as follows:

Water, volume, 5,500 to 100,000,000 B. T. U. per hour.

Water, volume, 0.55 to 10,000 gal. per minute.

Water, friction, 0.01 to 100 ft. per 100 ft.
Water, velocity, 0.7 to 25 ft. per second.
Water, diameter, ½ in. to 26 in. O. D. (commercial sizes).
Water, temperature drop, 10° to 40° F.
Steam, volume, 4,500 to 65,000,000 B. T. U. per hour.
Steam, volume, 4.5 to 65,000 lbs. weight per hour.
Steam, friction, 0.01 to 100 lbs. per square inch per 100 ft.
Steam, velocity, 7 to 250 ft. per second.
Steam, diameter, ½ in. to 26 in. O. D. (commercial sizes).
Steam, gauge pressure, 1 to 10 lbs. per square inch (heating).

ALLAN SLIDE RULE FOR FIGURING HOT WATER HEATING CALCULATIONS.



ALLAN SLIDE RULE FOR FIGURING STEAM HEATING WORK AND STEAM POWER PIPING.

Steam, gauge pressure, 50 to 250 lbs. per square inch (power).

To compute and arrange these data in tables or charts would involve an amount of labor that would be prohibitive. Unusual pains have been taken to make the manual, which accompanies each rule, clear and comprehensive.

The theory of the rule is first explained by an equation of general form and afterwards all of the actual equations on which the logarithmic gradations are based are given in full.

The method of operation is illustrated not only by practical examples involving single pipe lengths, but is carried much further by means of cuts of complete piping diagrams fully worked out for steam and water. In hot water heating, the use of the rule in both forced circulation work, is described, and a special table is provided giving the resistance of valves, fittings, etc., in terms of equivalent length of pipe of the same diameter.

The Allan slide rule is 20 in. long, made of mahogany, with graduations on white facings and is of the duplex pattern, the water scales being on one face and the steam scales on the other. It is provided with the latest patented feature for making adjustment which may be required by reason of wear or variation of atmospheric conditions and has the new Keuffel & Esser frameless glass indicator. It is listed at $15.30, including manual, and will be sent postpaid on receipt of purchase price by Charles D. Allan.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

DRAFT—

Draft for Steam Boilers. Chas. L. Hubbard. Chimneys, fans, and steam jets for supplying natural or artificial draft. 2,500 w. Natl Engr—Jan., 1915. 20c.

FANS—

Electric Fans in the Winter. Percy W. Gumaer. Explains how they may be installed in the cold-air intakes of furnaces to increase temperature and reduce coal consumption. 1,000 w. Elec Wld—Jan. 23, 1915. 20c.

HOTELS—

Heating and Ventilating Plant in the Palace Hotel Bellevue in Berne (Die Heizungs-und Luftungsanlagen im Palace-Hotel Bellevue in Bern). L. Greiner. Detailed plans with brief description. 2,000 w. Schweiz Bau—Jan. 9, 1915. 60c.

PIPING—

Heat Losses and Economical Design of Steam Piping. A. Langstaff Johnston, Jr. Discusses the laws governing the flow of steam in pipes, and presents curves with explanation of their use. 4,000 w. Engng Mag —Feb., 1915. 40c.

POWER PLANT APPARATUS—

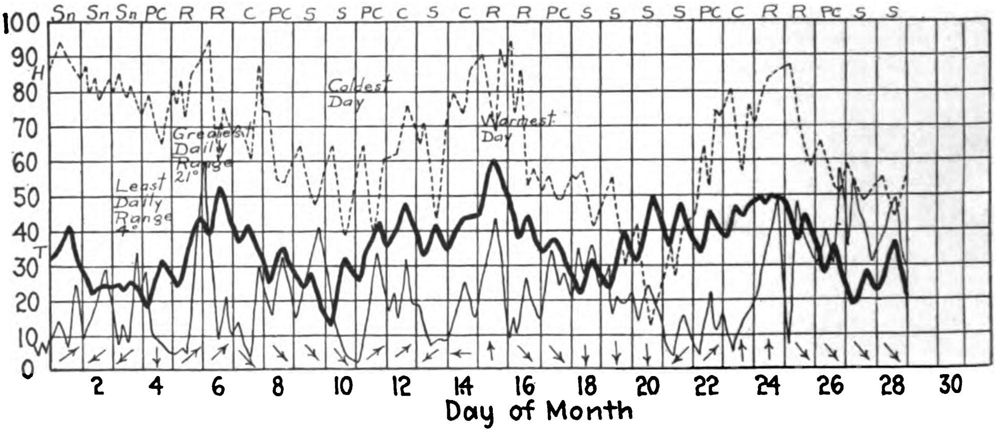
Chronology of Power Plant Apparatus. Charles J. Mason. The steam indicator; its history and improvements, is discussed in this article. Ills. Serial, 1st part 2,300 w. Natl Engr—Jan., 1915. 20c.

VENTILATION—

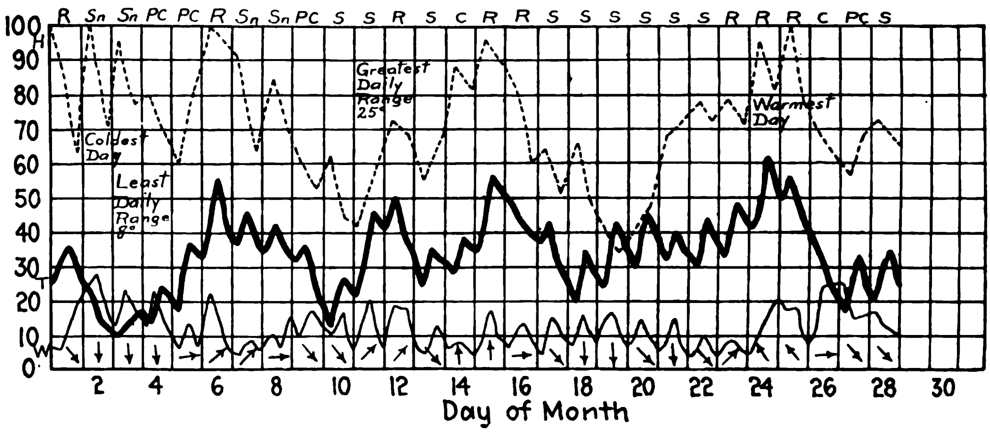
Ozone in Ventilation. J. C. Olsen and William H. Ulrich. An exposition of faulty methods of investigation heretofore employed. 3,500 w. Sci Am Sup—Jan. 16, 1915. 20c.

The Weather for February, 1915.

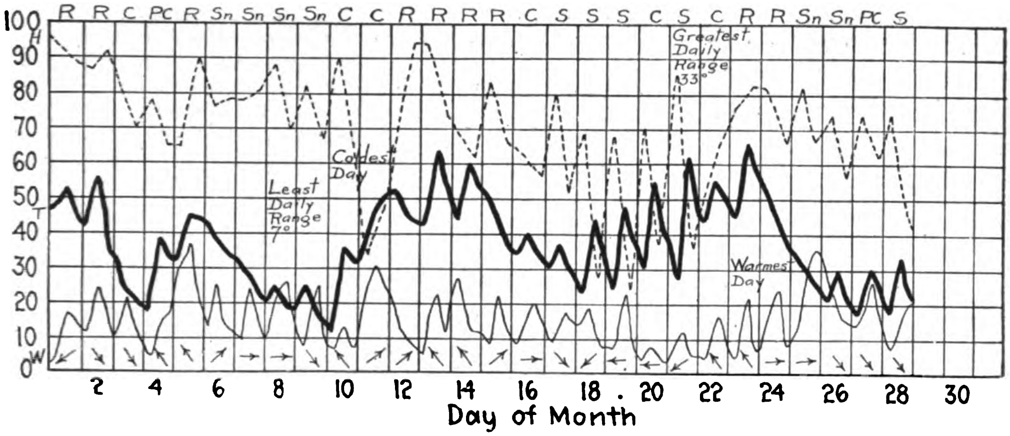
	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F	60	61	66	59	69
Date of highest temperature	15	24	23	13	12
Lowest temperature, degrees F	13	10	12	15	21
Date of lowest temperature	10	2	10	7	8
Greatest daily range, degrees F	21	25	33	24	26
Date of greatest daily range	5	11	21	13	10
Least daily range, degrees F	4	8	7	4	6
Date of least daily range	3	3	8	24	27
Mean. temp. for month, degrees F	35.2	33	37	34.5	40.5
Normal mean temp. for month, degrees F	30	28	31.8	25.4	33.5
Total rainfall, inches	5.03	3.47	2.24	1.92	2.3
Total snowfall, inches	4.5	5.1	1.5	0.5	1.6
Normal precipitation, this month, in	3.74	3.44	2.66	2.16	2.75
Total wind movement, miles	13358	7475	8052	8570	10796
Average hourly wind velocity, miles	19.9	11.1	12	12.8	16.1
Prevailing direction of wind	N.W.	N.W.	N.W.	S.E.	S.
Number of clear days	9	10	7	7	5
Number of partly cloudy days	7	8	3	4	8
Number of cloudy days	12	10	18	17	15
Number of days on which rain fell	9	12	14	11	8
Number of days on which snow fell	3	4	6	2	1
Snow on ground at end of month, inches	..	..	..	..	..



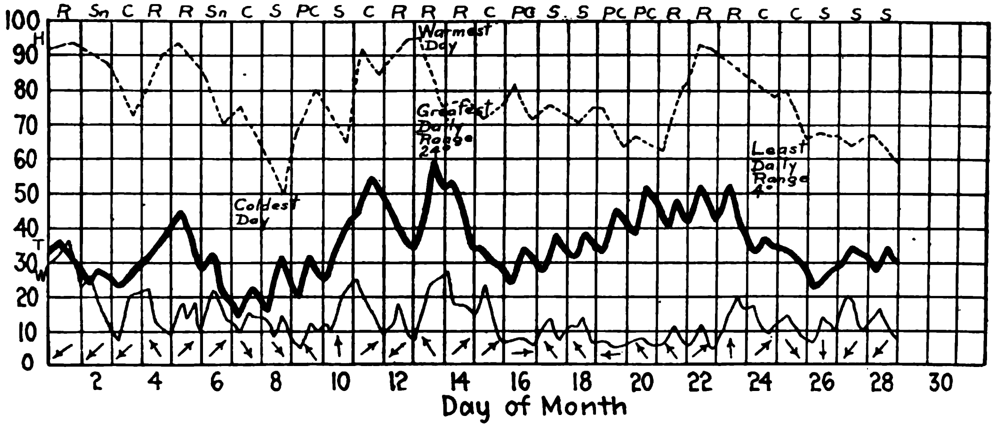
RECORD OF THE WEATHER IN NEW YORK FOR FEBRUARY, 1915.



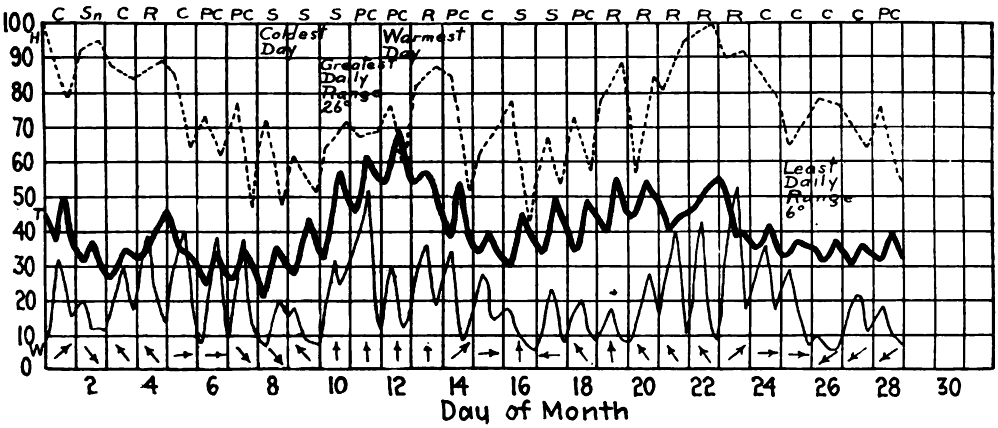
RECORD OF THE WEATHER IN BOSTON FOR FEBRUARY, 1915.



RECORD OF THE WEATHER IN PITTSBURGH FOR FEBRUARY, 1915.



RECORD OF THE WEATHER IN CHICAGO FOR FEBRUARY, 1915.



RECORD OF THE WEATHER IN ST. LOUIS FOR FEBRUARY, 1915.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

Test of Economy and Efficiency of Automatic Temperature Regulation in Office Buildings.

By F. A. Boos.

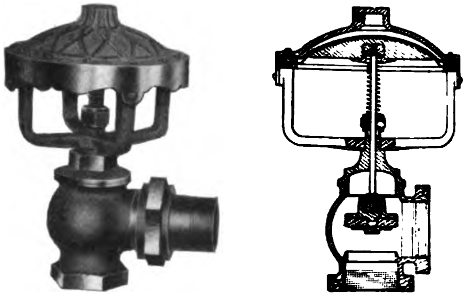
In order to determine closely the economy and efficiency of automatic temperature regulation in office buildings, a test was made in the Rialto Building, Kansas City, Mo., for the Johnson Service Company, by F. A. De-Boos and O. G. Ward, graduates of the College of Engineering, University of Wisconsin.

The room selected for the test was on the third floor, on the northeast side of the building. The room was of the following dimensions: 10 ft. 3 in. high, 15 ft. 2 in. long and 12 ft. 4 in. wide. Two windows on the 12 ft. 4 in. side had an area of approximately 50 sq. ft. The radiator was of about 45 sq. ft. area, being a two-column, 26 in., 17 section type. The steam riser was in one corner of the room and was covered. A branch line (uncovered) connected this riser with the radiator which was less than 2 ft. away. Heat was supplied by an overhead distribution, single pipe, air line vacuum steam system.

Smith-Rea-Lovitt, Architects
RIALTO BUILDING, KANSAS CITY, MO.

In making the test it was desired to know just how often the diaphragm radiator valve was opened and how long it remained open during each operation; also how closely the temperature was kept to the desired degree by the operation of the thermostat. To obtain this data, a Bristol recording thermometer and a Bristol recording pressure gauge were used and these were placed as shown in the accompanying illustration.

The recording gauge was connected to the air line leading from the thermostat to the diaphragm radiator valve. Thus when the thermostat operated, air pressure would be



TYPE OF DIAPHRAGM RADIATOR VALVE USED IN TEST.

thrown from the main air supply into the branch air line leading to the valve, and this pressure would be recorded graphically on the pressure gauge chart.

This diaphragm valve is operated by compressed air and it is so arranged that when air pressure is thrown on the diaphragm, it is forced downward. As the diaphragm bears directly upon the valve piston, it forces it downward, and thus shuts off the steam supply to the radiator. When the air pressure is released, a spring forces up the diaphragm and the valve is automatically opened. The thermostat is so arranged as to turn this compressed air into the branch leading to the diaphragm radiator valve, or release it from same, at slight temperature variations, and this control is designed to keep the temperature at almost a uniform point. When air is admitted at the top it forces the diaphragm down, as can be seen by noting the valve construction in the accompanying illustration.

The recording thermometer was hung as close to the thermostat as possible, so that there could be no difference in temperature at that point. The frames of the two instruments were thus made to touch. The thermostat was approximately 10 ft. from the radiator. The recording thermometer gave a continuous record of the temperature at the thermostat.

The thermostat first used was of the positive type, and this instrument is so arranged that when the valve is closed the full air pressure is thrown on the diaphragm valve and this is approximately 15 lbs. When the air pressure is released, it is released entirely, the pressure dropping to zero. The valve

therefore, is either in a fully open or a tightly closed position.

It must be remembered in speaking of pressures that *air pressures* are meant and not *steam pressures,* as no record was taken of the steam pressures, the air pressures being obtained simply because they afforded a means of recording the opening and closing of the diaphragm radiator valve.

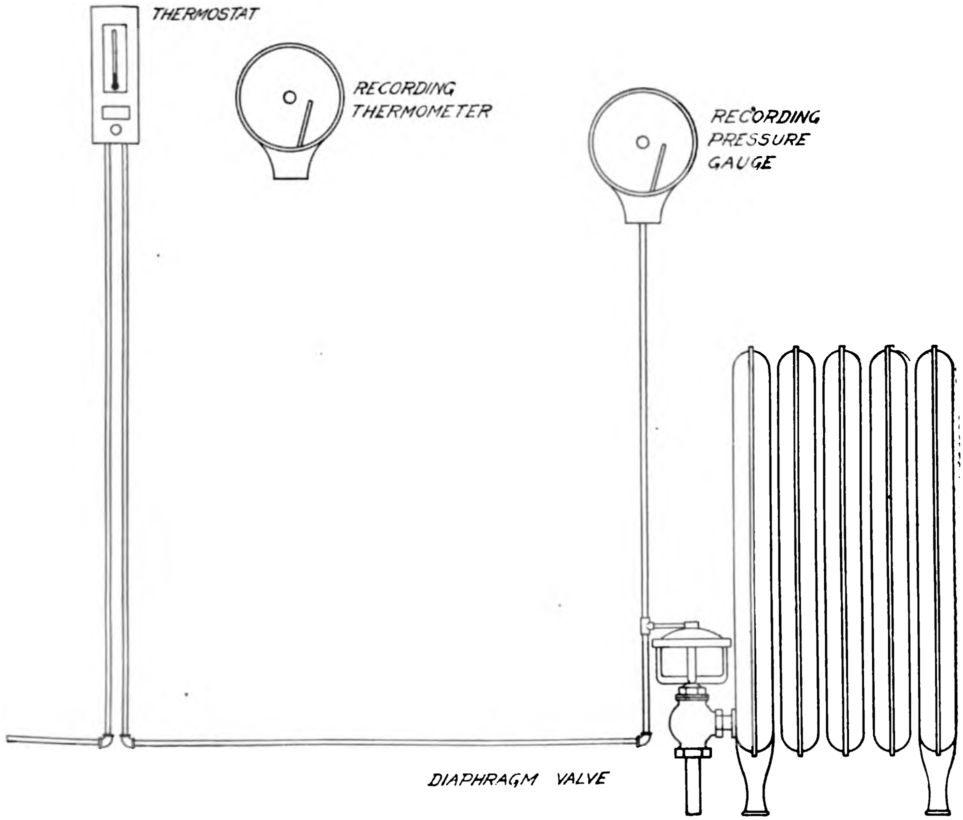
On the recording thermometer charts was later plotted in dotted lines the outdoor temperatures, which were taken from the U. S. Government records in the weather bureau office in Kansas City. These offices are directly across the street from the Rialto Building.

The tests were made by The Johnson Service Company with the co-operation of the owners of the building. The engineer in charge of the building, J. H. Duncan, assumed general charge, keeping the gauges under lock and key during the progress of the tests.

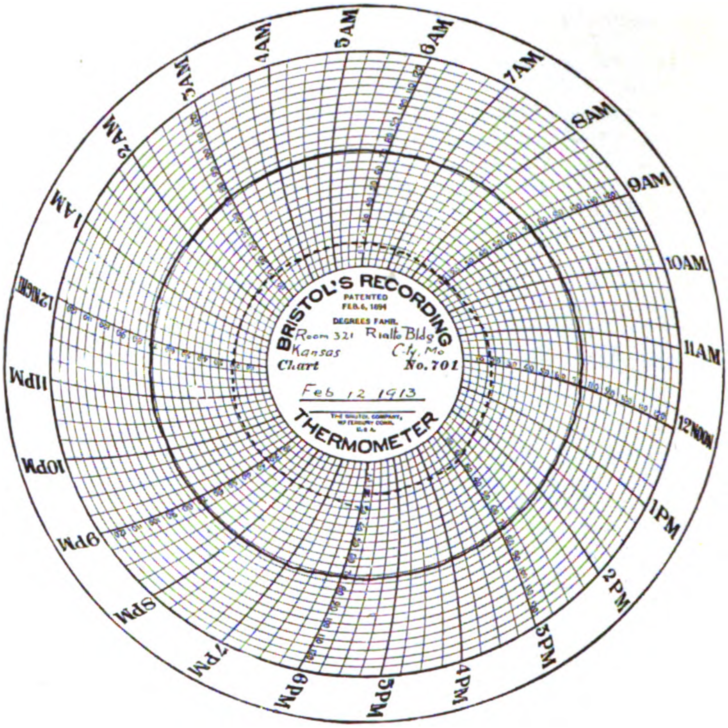
The coldest weather experienced during the test was on February 12, when the temperature varied from 11° F. to 29° F. This may be considered as severe winter weather for Kansas City and is somewhat colder than the average winter day. February 22 was also a day of severe winter weather, the temperature averaging but 1° higher than on February 12.

The two charts for February 12 are shown herewith. These should be studied together as they are inter-related, the temperature varying, of course, as the diaphragm valve is opened and closed. On the recording thermometer chart the outside temperature is shown by dotted lines. The variations in the air pressure on the recording pressure gauge chart (variations between 14½ and 15 lbs., making a slightly waving line) are caused by the operation of the automatic air compressor which operated about once in 15 minutes.

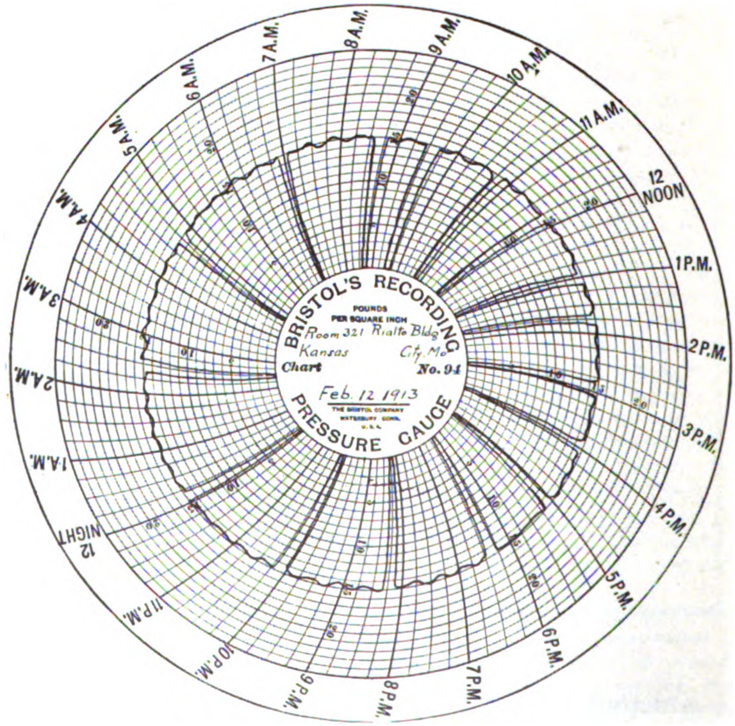
From an inspection of the recording thermometer chart it will be noticed that the outside temperature was 29° at 6:00 P. M. and went down steadily to 11° at about 8:00 A. M., and was about 20° above zero at 6:00 P. M., an average of about 19.5° F. for the 24-hour period. The indoor temperature was maintained between 70.5° and 72.5° F., or a little



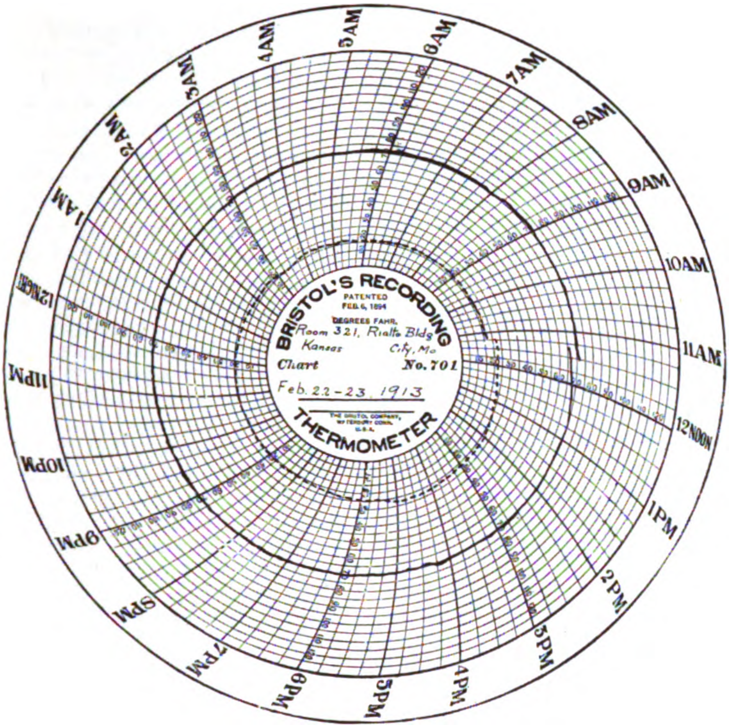
ARRANGEMENT FOR TESTING AUTOMATIC TEMPERATURE REGULATION APPARATUS.



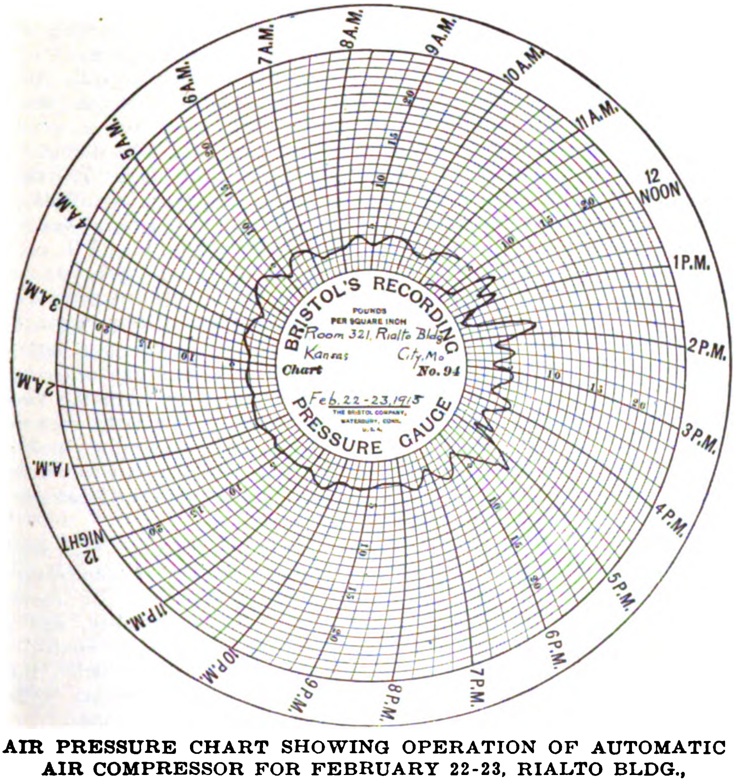
TEMPERATURE CHART FOR FEBRUARY 12, RIALTO BUILDING.



AIR PRESSURE CHART SHOWING OPERATION OF AUTOMATIC AIR COMPRESSOR FOR FEBRUARY 12, RIALTO BUILDING WHEN POSITIVE THERMOSTAT WAS USED.



TEMPERATURE CHART, FEBRUARY 22-23, RIALTO BUILDING.



AIR PRESSURE CHART SHOWING OPERATION OF AUTOMATIC AIR COMPRESSOR FOR FEBRUARY 22-23, RIALTO BLDG., WHEN INTERMEDIATE THERMOSTAT WAS USED.

higher than 50° above the average outdoor temperature.

The pressure chart shows the thermostat operated 32 times, opening the valve at 16 different times and closing same 16 times at short intervals. In fact, the valve was held open only from 5 to 10 minutes at a time, or approximately 2 hours out of the entire 24, or about 8% of the time. It will be observed that the indoor fluctuations of the temperature follow the valve operations very closely, lagging a little behind same, as would be expected.

For instance, it will be observed on the recording thermometer chart between 12:00 noon and 1:00 P. M. the temperature is gradually falling from about 72° till just about 1:00 P. M. it almost reaches 70°. By now referring to the recording pressure chart, it will be noted that at about 12:55 the thermostat operated, releasing the air pressure (which dropped at once to zero) thus permitting the valve to open and to turn heat into the radiator.

Inside of ten minutes (at about 1:05 P. M.) the room temperature has risen to almost 71° and this slight increase of less than 1° is sufficient to cause the thermostat to again operate to close the valve, as is shown by the pressure jumping up to 15 lbs. on the pressure recording chart. The temperature, however, still rises another fraction of a degree, due to the fact that the radiator is hot and although the steam is shut off, it continues to radiate heat for a brief interval.

At about 1:15 P. M. the temperature again begins to fall slightly and at about 1:37 P. M. the thermostat operates to let in more steam. At about 1:47 P. M. the thermostat again operates shutting the radiator valve and cutting off the steam supply. The temperature increases slightly, however, for a few minutes when it begins to fall again, and the thermostat operates once more at about 2:50 P. M.

The thermostat operates in each case on less than 1° variation in the room temperature. As would be expected it operated more frequently while the outdoor temperature was around 10° to 15° than it did during the time the outdoor temperature was fluctuating between 20° and 30°.

During the next several days the weather moderated to such an extent as to permit the steam being shut off the building at night and the records, while kept, do not afford anything of special interest. The thermostat operated with less frequency, of course, as the weather moderated.

Another cold wave came on February 22, and it was decided to test out an intermediate thermostat, substituting it in place of the positive. This instrument is so designed as to throw varying pressures on the valve diaphragm so as to hold it in all sorts of positions from fully open to tightly closed, and also at all intermediate stages.

The pressure record, while interesting, does not afford sufficient data to show just how long the radiator was actually in full operation. For a very considerable part of the time, after the room had reached the desired temperature, the thermostat held the valve in a slightly open position, permitting just enough steam to enter the radiator to keep it slightly warm thus causing hardly any fluctuation of the indoor temperature. The two charts are shown herewith.

When the test was started at 11:15 A. M. the room temperature was 65° F. At 12.30 it reached 70° and it will be noted that from 12:15 on till 12:30 the thermostat kept increasing the air pressure upon the diaphragm valve till it reached 6.5 lbs., which was just about sufficient to close it. The temperature began to drop just a fraction, and the thermostat began releasing the air and permitted the valve to open more and more until about 1:30 P. M. it had the valve practically fully open. The temperature began to rise and the thermostat immediately began closing the valve, piling up a pressure of about 8.5 lbs. in the next fifteen minutes.

From that time on it seems to have struck a "happy medium," holding the valve open just sufficiently to permit exactly the right amount of steam to enter the radiator, although at 5:00 P. M. the intermediate thermostat had built up a pressure of 9 lbs. which was gradually diminished to 2.5 lbs. during the next hour. The thermostat seems to have then struck a still *"happier medium"* and for the next several hours hardly varied the pressure more than 1 lb. on the diaphragm valve. The temperature was maintatined at a remarkably uniform point as shown by the recording thermometer chart.

The charts for the days, Feb. 12 and Feb. 23, are selected from the others simply for the reason that they were the two coldest days encountered. The tests were not begun until Feb. 12, and the weather moderated so much after the 23rd that it was decided to stop the tests, as little new information could then be derived.

The results of these tests tend to show that a reliable system of temperature regulation is a great fuel saver. A correctly designed plant, properly installed, and equipped with automatic temperature control would require perhaps 25% less radiation than one not so equipped. A fuel saving, 25% at the minimum, should be expected.

Future tests will probably be made in more

detail at a later date, covering records for an entire winter and taking into consideration the steam pressures, condensation, etc., and also including data for comparison on room temperatures, steam consumption, etc., of buildings of similar character which are not automatically controlled.

M. S. Cooley Enters Vapor Heating Field.

As announced last month, in the notice of the reorganization of the Hutchison Vapor Heating Corporation, of Washington, D. C., the position of chief engineer of the corporation has been taken by M. S. Cooley, formerly assistant superintendent of the Mechanical Division, Supervising Architect's Office, United States Treasury Department. Mr. Cooley is a graduate of Cornell University, taking his M.E. degree with the class of '96. Immediately after his graduation he was employed in various positions controlled by the architect of the State of New York and, for the past twelve years, as heating and ventilating engineer of the Supervising Architect's office of the Treasury Department. He has superintended the design and installation of the heating plants in all public buildings during that period. He is a member of the American Society of Heating and Ventilating Engineers to which he has contributed a number of papers on heating and vacuum cleaning subjects. He is also the author of the well-known work on "Vacuum Cleaning Systems." Mr. Cooley's many friends will wish him a full measure of success in his new position.

Operating Costs of Electric Heating Devices.

In connection with the use of electric radiators for warming purposes, the following. figures are given as applying to the Apfel electric heating devices, which were illustrated and described in the last issue. This system, it is claimed, is actually 100% efficient; that is, every B.T.U. generated is generated and used at the point where it is desired, and not in a boiler room or in a basement, whence it must be conveyed, with more or less loss, to the rooms where it is to be used. In this way all losses of circulation and insulation are eliminated.

It is figured that, with the Apfel system, 1 K.W. of energy will properly and amply heat 30 sq. ft. of direct radiating surface. In Washington, where the system has been developed, the coals average 11,000 B.T.U. per pound. The average cost of Washington coal, delivered in a residence basement, is $7.00 per ton. The average net efficiency in available B.T.U. delivered from the radiator into the room where it is desired will not exceed 19.2%, after the flue losses, radiation losses from boiler and mains, and energy losses of friction and circulation are deducted. Therefore, from the above figures, with an electric heating system which is 100% efficient, it is shown that electricity at 56 cents per kilowatt hour is the full equivalent of coal in that State.

In support of the foregoing we are informed that in the offices of the Great Western Stove Company, in Seattle, which was formerly equipped with a hot water heating system, the coal bills for two years, covering a heating season of seven months each year, averaged slightly over $8.00 per month. Since installing the Apfel electric heating system last Fall, the largest bill for the coldest month was a little over $9.00. The reason for this is explained on the ground that the heat is turned on automatically at 5 or 6 A. M. and turned off again as soon as the offices are warmed.

In another case, in a seven-room Seattle residence, containing over 400 sq. ft. of direct radiation, where the electric radiators used are wound for a consumption of less than 30 watts per square foot on the high heat, the entire house is fully heated to 70° F., or over, except at night or at such times as the occupants are out for the day, when the time switch is set to turn on about 1½ hours before their return, so that the house will be warm at that time. The total cost for the heating of this residence during the winter of 1913-1914 was $88.00. The heating plant received absolutely no care or attention during that time, except that the time switch was set at night or when going out for the day. Nothing was paid for repairs or renewals of any nature.

New Books.

500 Plain Answers to Direct Questions on steam, hot water, vapor and vacuum heatting, is the title of a new book by Alfred G. King. This work is intended primarily for the younger inexperienced fitter, but many of the older men in the trade will find it useful as a reference book. The text is arranged in question and answer form and is always to the point. In case the proposed licensing laws are passed in such States as Pennsylvania and Massachusetts, as seems likely, the book will have a very timely value in aiding those who may then be preparing for examinations. The subjects treated by the questions and answers include: Theory and laws of heat; methods of heating, chimneys and flues, boilers for heating, boiler trimmings and settings, radiation, steam heating, hot water heating, including two-pipe gravity work, circuit systems and overhead systems;

accelerated hot water heating, vacuum vapor and vacuo-vapor heating, mechanical systems of vacuum heating, and greenhouse heating. Size 6¼ x 9¼ in. Pp. 200, 127 ills. Published by the Norman W. Henley Publishing Co., 132 Nassau Street, New York, or may be had through the book department of THE HEATING AND VENTILATING MAGAZINE.

DESIGNING, HEATING AND VENTILATING SYSTEMS, by Charles A. Fuller, is one of the interesting new books of the year, embodying the data contained in the lecture courses given by the author before Y. M. C. A. and other classes. The work covers the practical application of engineering rules and formulas in every-day use, in designing all types of heating and ventilating equipment. The needs of the less technical mind have been considered throughout and no attempt is made to explain the derivation of the rules used. The fact that the author has applied the formulas in his own work as a consulting engineer is given as sufficient evidence of their reliability. Among the most useful features of the book are the typical problems in the solution of which the reader is called upon to apply the information immediately preceding. In many cases the solution is presented in detail. A chapter on hotel ventilation shows the importance of the problem of kitchen ventilation. Many useful hints are given covering the ventilation of ranges and other cooking apparatus. Size 6x9 in. Pp. 220, 78 ills. Published by the David Williams Co., 239 West 39th Street, New York, or may be had through the book department of THE HEATING AND VENTILATING MAGAZINE.

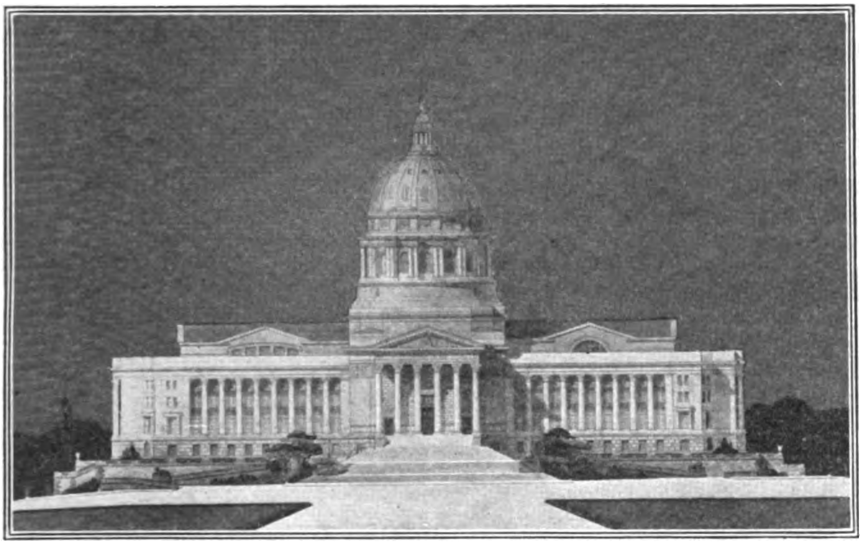
CORK: ITS ORIGIN AND INDUSTRIAL USES, by Gilbert E. Stecher, is the title of a timely monograph, published to supply little-known facts regarding this valuable staple. Although the book does not go into the insulating properties of cork, those who are interested in knowing its nature as well as the history of the cork industry, will find much to enlighten them in this manual. Among the subjects discussed are the origin of corkwood, including the territory of growth and attempts to transplant the seed. Size 5½ x 8 in. Pp. 83. Price, $1 net.

ADVERTISERS' INDEX

*Every other month.

THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK MAY, 1915



THE NEW STATE CAPITOL, JEFFERSON CITY, MO.

Heating and Ventilating Plant for the Missouri State Capitol

REVERSIBLE SYSTEM OF AIR SUPPLY FOR HOUSE AND SENATE CHAMBERS.

One of the largest building operations undertaken in some time is that of the new Capitol Building for the State of Missouri which is being erected at Jefferson City, Mo. Work is at present proceeding in a gratifying manner, but owing to the magnitude of the undertaking the exact date of occupancy is not as yet definitely determined. Our readers will probably be able to better grasp the meaning of this project when it is understood that the structure is costing close to $3,000,000.

This magnificent piece of architecture is being erected from plans and specifications prepared by Tracy & Swartwout, architects, of New York, and the mechanical equipment is being installed under the supervision of the Richard D. Kimball Co., engineers, New York. The general contract is rapidly being pushed to conclusion by the John Gill & Sons Co., general contractors, and the equipment is being installed by the Hanley-Casey Co., Chicago, contractors for the mechanical equipment.

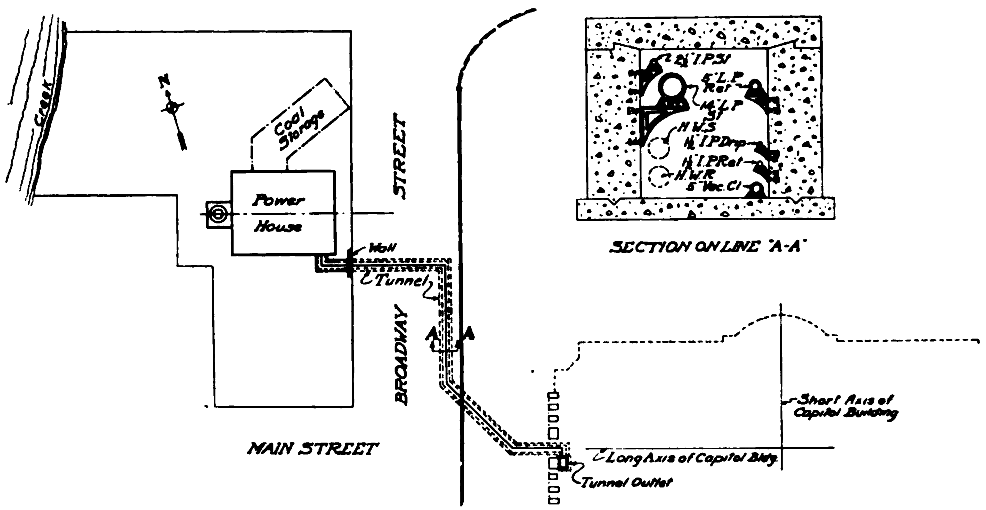


FIG. 1.—PLOT PLAN OF MISSOURI STATE CAPITOL AND POWER HOUSE AND PIPE TUNNEL.

ARRANGEMENT OF VARIOUS FLOORS.

The building is erected on concrete piers so as to bring it to a proper level with the grade of the surrounding streets and consists of a basement, ground floor and first, second and third floors. The basement is almost entirely given over to the uses of the mechanical equipment. All horizontal duct work, steam supply and return pipes, intermediate pressure lines, vacuum cleaning mains, together with the required fans, heaters, motors, air washers, kitchen, are placed on this level.

On the ground floor the natural resources museum occupies the center of one wing and a historical museum the center of the other wing. In the center of the building is a circular rotunda under the large dome and in the rear of this is located the dining room. Various state departments also find quarters on this floor.

The first floor, which is entered direct from the street by means of an imposing flight of steps, somewhat on the style of the United States Capitol at Washington, is occupied in the center by a continuation of the above-mentioned rotunda which gives entrance to corridors connecting with all other parts of the building. The two wings on this level are occupied by the upper parts of the two museums (which are of two-story height) and the rear is utilized for the Governor's reception room and executive offices. Other departments, together with the board of education "conference room," are placed on this floor.

The second floor gives entrance from its central rotunda to the floor of the House of Representatives on one side and to the floor of the Senate chamber on the other side. Connected to these are various lounge and committee rooms, while in the rear is the legislative library.

On the third floor the arrangement is quite similar to the second, the House and Senate galleries being located at this level and the upper part of the library. Various other small offices and some space not as yet assigned is included on this floor.

CAPITOL SERVED FROM SEPARATE PLANT.

The Capitol building is supplied with heat, light and power from a separate and distinct power house located approximately 250 ft. distant, the piping being carried underground in a tunnel which terminates in the basement of the Capitol building. A plot plan showing the relative location of the power house and the tunnel running to the Capitol building is given in Fig. 1, which also includes a detail cross section of the tunnel on Line A-A.

The power plant equipment consists of five Heine water tube boilers of 250

H. P. capacity, with space for the future installation of a sixth boiler.

The boilers are provided with damper regulators, 12-in. steam gauges, Reliance water columns and each has an 8-in. outlet for steam supply and a 5-in. outlet for safety valves. On each steam outlet an 8-in. automatic combination non-return and stop valve is placed with a pilot valve, and on the safety valve outlets are placed two 4-in. flanged pop safety valves set on a flanged safety valve yoke and arranged to blow at 130 lbs. The blow-off connections are 2½ in. These boilers are equipped with Murphy stokers. The stokers have a rated capacity of 250 H. P. each with a continuous operation overload capacity of 50% and a two-hour overload capacity of 75%.

An open type combined storage and feed water heater with a capacity for heating water for 1350 H. P., including 25% for overload and 50° F. initial temperature of water is provided. In connection with this is used a 3½-in. double-filtration multiple-cartridge feed-water filter of 1,250 H.P. capacity with a by-pass. The hot water tank for domestic hot water supply is installed in the power house to furnish hot water service to the Capitol building, this tank having steam coils and thermostatic regulation.

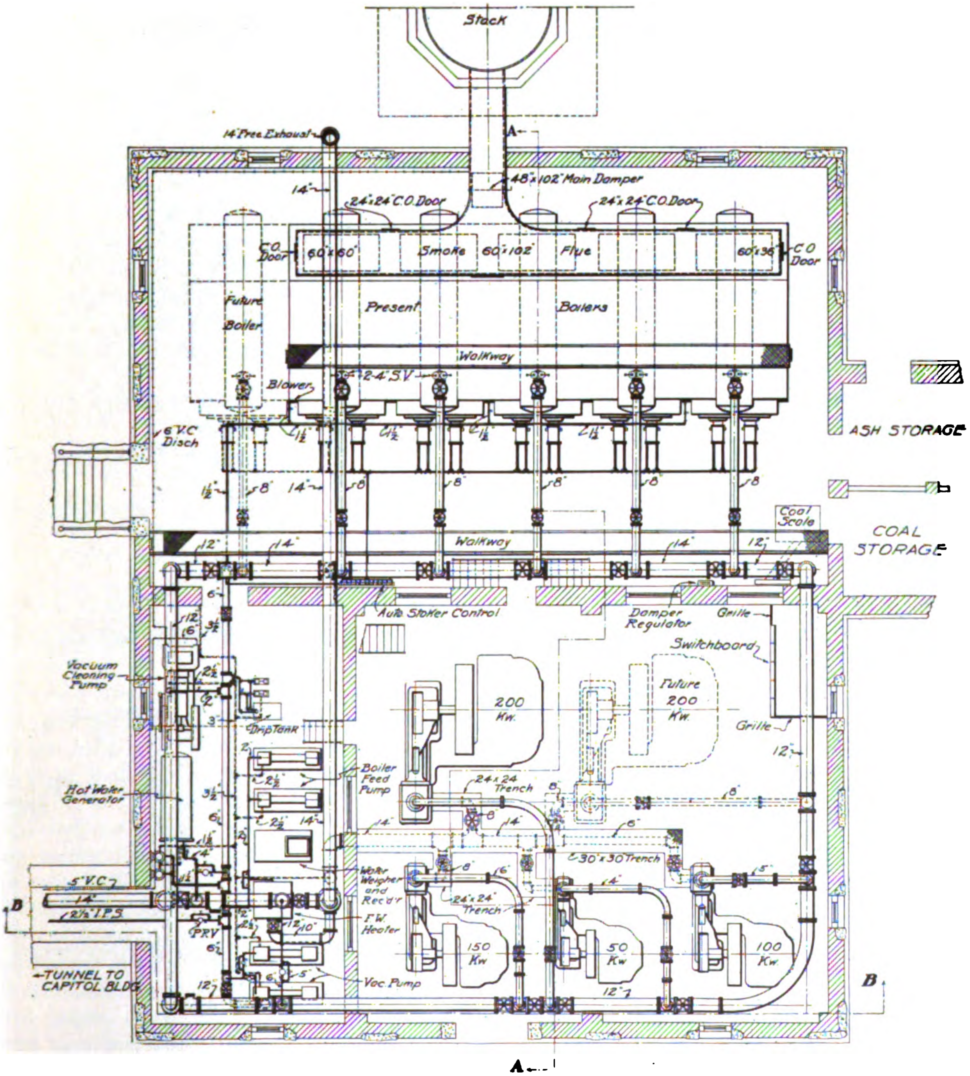


FIG. 2.—PLAN OF POWER HOUSE FOR MISSOURI STATE CAPITOL.

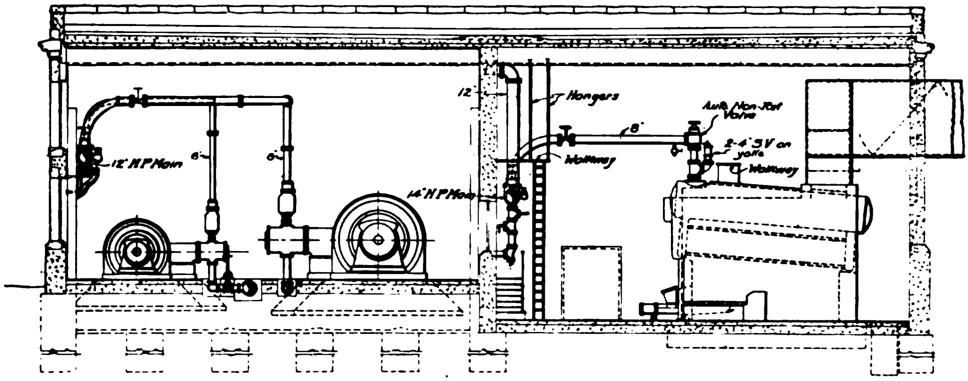


FIG. 3.—SECTION A-A, POWER HOUSE FOR MISSOURI STATE CAPITOL.

The boiler feed pumps consist of two 12-in.x8½-in.x12-in. pumps of Davidson make for a working pressure of 150 lbs. There are also installed two 14-in.x16-in.x16-in. vacuum pumps of Davidson make for pumping the heating returns to the air separating tank and feed water heater and maintaining a vacuum on the Capitol heating system. The blow-off tank is 36-in.x72-in. of cast iron with 4-in. drain connection and 4-in. vapor pipe run above the building roof. This tank has a cooling coil containing 20 sq. ft. of surface supplied with 1 in. cold water connection. The outboard exhaust is carried through the roof and is provided with a Swartwout muffler exhaust head of No. 16 galvanized iron with 1¼ in. drip.

Pressure reducing valves are installed in the power house as follows:

One 6 in. x 12 in. for the heating system reducing from 125 lbs. to 4 lbs.

One 2½ in. x 2½ in. for intermediate pressure steam from 125 lbs. to 40 lbs.

One 2½ in. x 2½ in. for the hot water tank from 125 lbs. to 4 lbs.

The back pressure valve which is located in the exhaust pipe in the pump room is a 14 in. multiple flanged noiseless back pressure and safety valve, adjustable from atmospheric to 8 lbs. of back pressure.

Anderson traps for various purposes are installed as follows:—

No. 1 for the return from hot water tank, 1½ in. size.

No. 2 for intermediate pressure drips, 1¼ in. size.

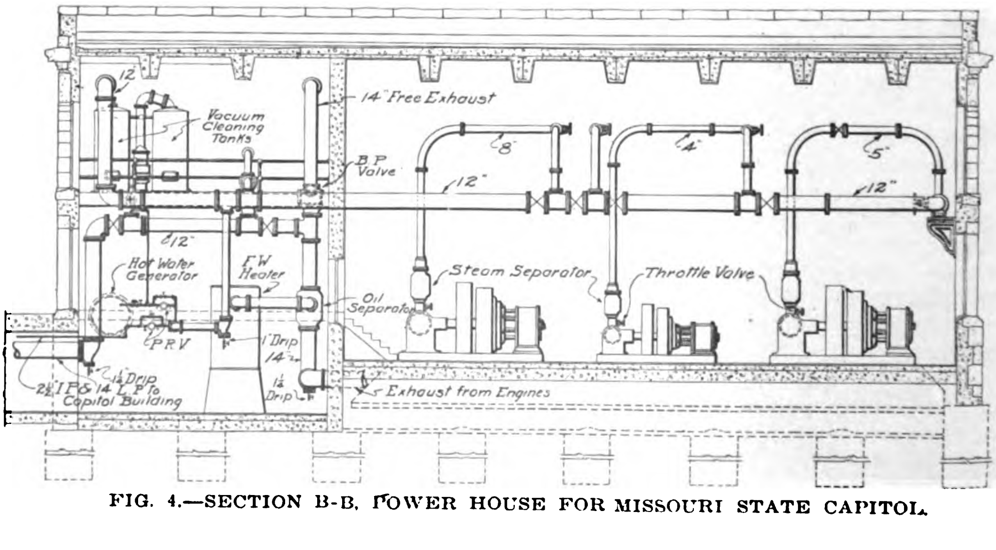


FIG. 4.—SECTION B-B, POWER HOUSE FOR MISSOURI STATE CAPITOL.

No. 3 for engine and separator drips, 2 in. size.

No. 4 for greasy drips, 2 in. size.

No. 5 for high pressure drips, 2 in. in size.

In Fig 2 a complete floor plan of the power house is given, showing the general arrangement and all the main piping, sectional elevation on Line "A-A" and Line "B-B" being indicated in Figs. 3 and 4.

THREE GENERAL DIVISIONS OF HEATING SYSTEM.

The heating system in general for the Capitol building may be separated into three general divisions, direct radiation being used to supply heat to the Senate chambers and adjoining rooms in one wing and to the House of Representatives chambers and adjoining rooms on the other, while the dining room, Governor's section and legislative library in the central portion are heated entirely by a hot blast system. In general, the radiators are exposed and located beneath the window sills, while those located in the corridors are recessed behind grilles. The recessed radiators are arranged as shown in the typical case given in Fig. 5. The radiators concealed or recessed in the walls and under window sills are set in galvanized iron enclosures of No. 20 gauge using enclosures consisting of bottoms, tops, ends, backs and front, excepting only the portion occupied by the grilles. Where these recesses occur in the outside walls they are backed with ½ in. asbestos sheets placed over the entire outside surface which is in contact with the wall.

The radiator valves on the hand controlled radiators are at the top of the radiator and are of the graduated control type containing an auxiliary stop valve. Where the radiators are concealed behind grilles the spindle of the valve is connected to an extension piece with two ball joints and the handle carried out and mounted on the face of the grille together with its graduated dial. Each radiator and coil (excepting the indirect stacks), and each drip point in the steam main, is equipped with a nickel plated non-by-passed liquid thermostatic return valve with strainer. On the return connection of each of the indirect stacks a water seal combination air and water relief float valve is installed.

In portions of the attic and in the upper part of the large dome pipe coils are used, these being supplied with drip pans of No. 20 gage galvanized iron 6 in. deep and pitched to drain through 1 in. connections into nearby leaders. The coils used in the dome are shown in plan in Fig. 6 and in cross section in Fig. 7.

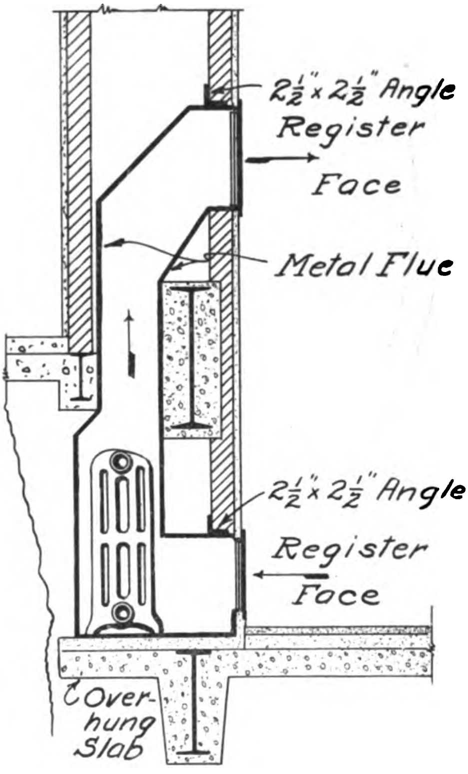


FIG. 5.—PLAN AND ELEVATION OF TYPICAL CONCEALED RADIATOR, MISSOURI STATE CAPITOL.

They are arranged in three tiers 5 ft. apart, each quarter of the dome having three coils 60 ft. long with six rows of 1½ in pipe.

The direct radiators are in general of a plain style and hot water pattern arranged with the various number of columns and heights as required, some of the window radiators being of the Rococo pattern. In certain locations, where space was limited, pressed steel radiators were used.

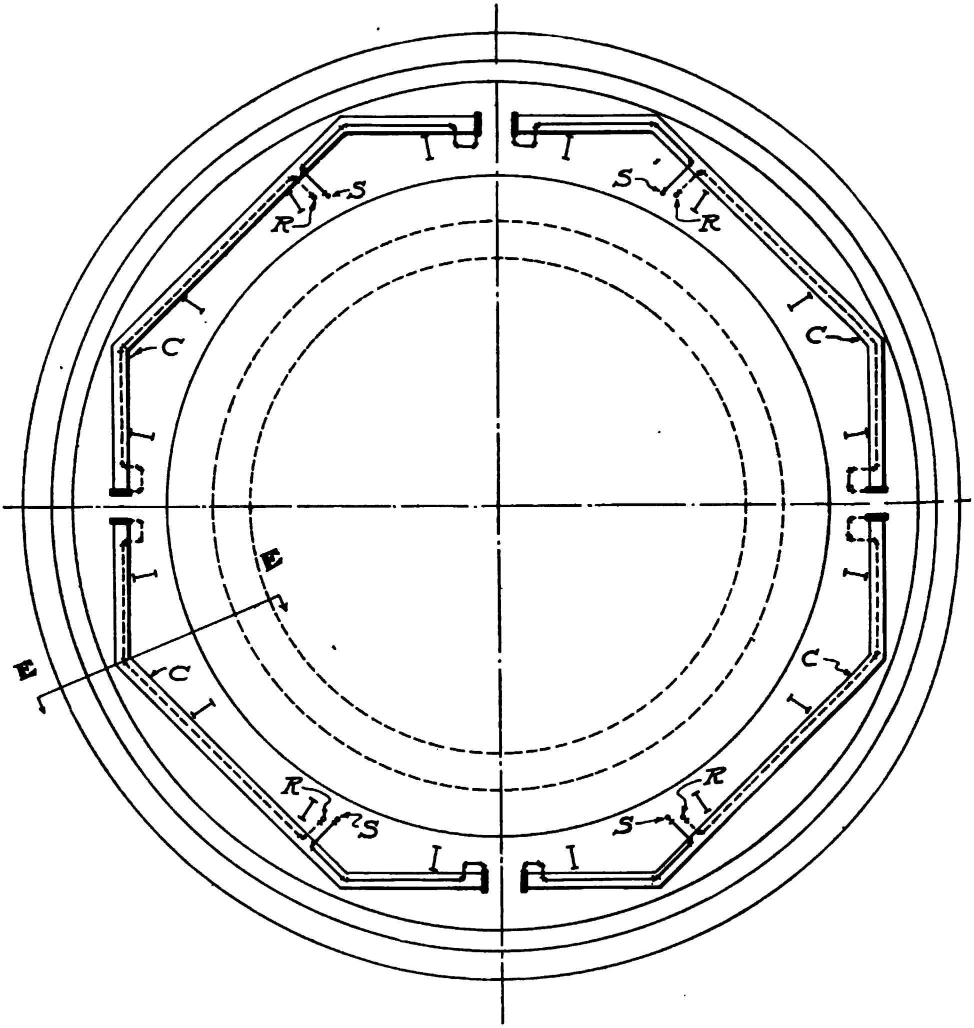


FIG. 6.—PLAN OF DOME COILS, MISSOURI STATE CAPITOL.

The steam pipes throughout are pitched about 1 in. in 10 ft. and the return lines 1 in. in 15 ft., excepting the large steam main in the basement of the Capitol building which is run practically level and dripped through the runouts which are pitched 1 in. in 8 ft.

Where reductions in sizes are made in the steam main eccentric reducers are used, these being located approximately 18 in. beyond the branch causing the reduction. Standard weight pipe is used throughout with standard weight fittings for all low pressure lines except on the blowoff piping. The 14 in. high pressure boiler drum is made of extra heavy pipe and pipe bends of full weight pipe. The standard weight fittings in the power house of 4 in. and larger in size are flanged. Extra heavy fittings are used on all lines 2½ in. and above for high pressure, those 4 in. and over being long turn pattern and flanged.

The following sizes of supply and return pipe connections are made to the various radiators.

Supply Valve. Inches Diam.	Run out. Inches Diam.	Surface. Sq. Ft.	Return Valve. Inches Diam.	Run Out. Inches Diam.
½	¾	0-25	½	½
¾	1	26-75	½	¾
1	1¼	76-125	¾	¾
1¼	1½	126 and over.	¾	1

Runouts over 5 ft. in length are made one size larger, reducing at the radiators.

The total amount of direct radiation installed is as follows:

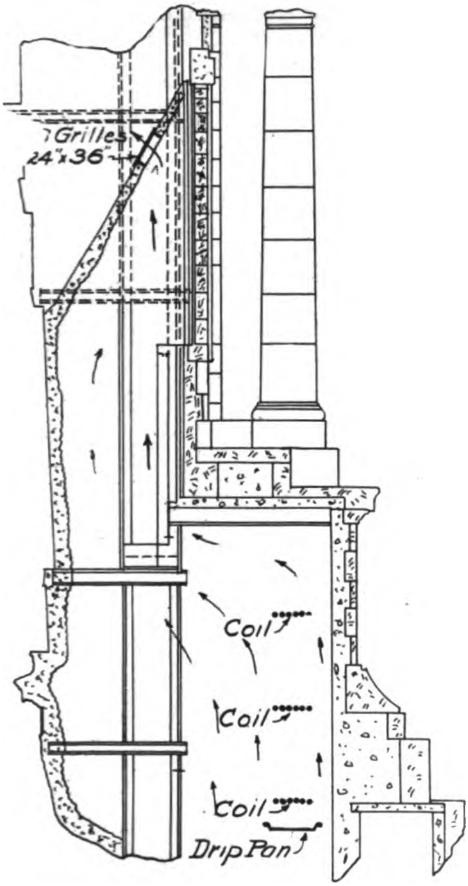


FIG. 7.—SECTION E-E, DOME COILS, MISSOURI STATE CAPITOL.

Ground floor	7,240 sq. ft.
First floor	5,080 sq. ft.
Second floor	3,043 sq. ft.
Third floor	5,166 sq. ft.
Attic, dome coils and library	5,052 sq. ft.
Total	25,582 sq. ft.

Automatic control is applied to the principal rooms, the radiators automatically controlled being equipped with diaphragm valves. The thermostats are of the intermediate action type. The thermostatic system is being installed by the Standard Regulator Co. and is operated by compressed air supplied by two vertical steam-driven air compressors supplying air to a storage tank from which it is piped through the tunnel to the Capitol building.

A system of intermediate pressure mains is also extended through the basement of the Capitol building from the power house tunnel outlet, this steam being used for cooking in the kitchens and for other purposes in the four laboratories.

All steam pipes throughout the work are covered with 85% magnesia sectional pipe covering.

The return pipes are covered with air cell covering. The covering on the high pressure pipes 6 in. and above in the power house and tunnel is 1½ in. thick and elsewhere is 1 in. thick, excepting on the return risers and runouts where it is ¾ in. thick. The covering of screwed fittings is asbestos cement felting while the body of all flanged fittings and valves 2½ in. and larger is covered with similar asbestos cement felting canvassed. Flanges are covered with removable and replaceable flange coverings jacketed with 10 oz. canvas.

The various fans and capacities as installed in the Capitol building are as follows:

	Double Width. C. F. M.	H. P. Motor
For Senate supply	30,000	20
For Senate exhaust	33,000	16
For House of Representatives supply	37,000	25
For House of Representatives exhaust	38,500	18
For Governor's section supply and exhaust (each)	16,000*	20
For east toilet rooms exhaust	6,600	4
For west toilet rooms exhaust	7,100	5
For west kitchen exhaust	3,500	2

*Single width.

The Vento heaters installed for the Senate supply system consist of 72 sec-

tions of 60 in. Vento arranged two groups high, two groups wide, and two rows deep for a tempering heater and 108 sections 60 in. high arranged two groups high, two wide and three deep for a secondary heater. The House of Representative tempering heater consists of 84 sections of 60 in. heaters arranged two groups high, two wide, and two deep. On the secondary heater 126 sections are used arranged two groups high, two wide and three deep.

In the Governor's and library portion a total of 32 sections of 60 in. Vento heaters are used on the tempering coil arranged one high, one wide and two deep, while the secondary heater has exactly double this arranged four rows deep.

ARRANGEMENT FOR REVERSING SYSTEM.

Rotating dampers are placed in the main supply and exhaust ducts for both the House of Representatives and the Senate so that the supply and exhaust air may be reversed at this point in such a manner that all the top registers will be supply registers and all bottom regis-

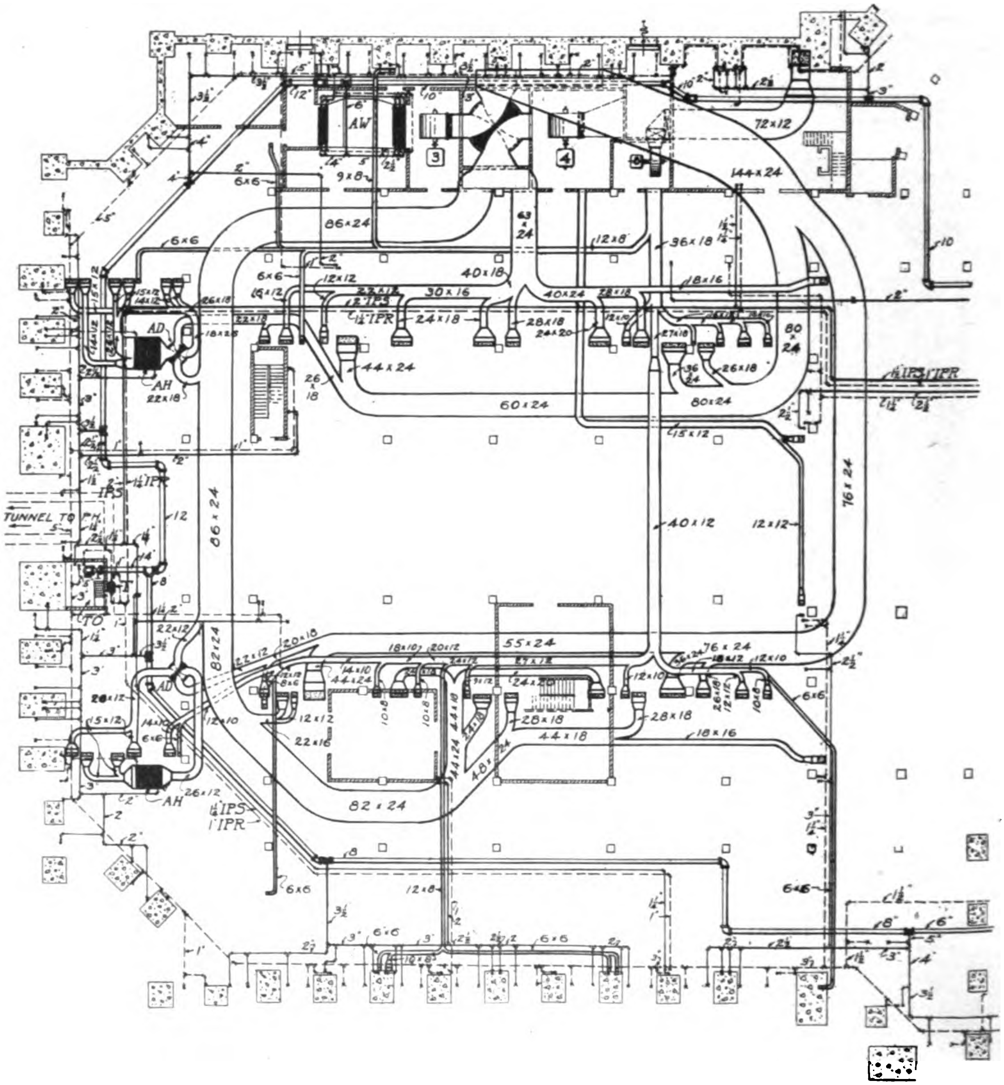


FIG. 8.—PIPING AND DUCT WORK IN BASEMENT OF MISSOURI STATE CAPITOL, SHOWING REVERSING SYSTEM.

ters exhaust registers or vice versa, as desired. Owing to the necessity of using auxiliary heaters in the two groups of ducts going into the lounging rooms it is, of course, impossible to reverse the flow past these heaters without heating the exhaust air coming from the room. This made it necessary to install two smaller auxiliary rotating dampers which operate so as to oppose the change of flow when altered by the main damper. A study of the duct layout shown in Fig. 8 will make this method of reversal clear.

In this figure the air washers are indicated by AW, the auxiliary rotating dampers by AD, the auxiliary heaters for the lounge rooms by AH, and the tunnel outlet to TO. Intermediate pressure lines are marked IPS or IPR according to whether they are supply or return, and a trap is indicated by T.

Apparatus No. 3 is the supply for the House of Representatives, while Apparatus No. 4 is the corresponding exhaust. The fan and motor marked No. 8 are for toilet exhaust on this side of the building. On the opposite side the Senate supply and exhaust is run in a similar manner, the hot blast system used in the central rear portions being situated between the two. In the Senate and House chambers and in the galleries for same mushroom inlets are used, these being fastened to the concrete floor by means of screws driven into plugs in the floor. No. 20 gauge galvanized iron sleeves with a narrow flange on the top are set in the concrete floors connecting the mushrooms with the space below.

The registers and grilles throughout, while in some cases of special design, are, in general, plain latticed face; those set in wire lath and plastered partitions and also in terra cotta and concrete walls have cast iron wall frames. Under each floor register is placed a screen of ¼-in. mesh galvanized iron wire bound over a wire frame.

All the supply air used is washed by the use of modern type air washers. They are installed of capacities as shown below.

The velocity of the air through the washers does not exceed 500 ft. per minute in any case.

A vacuum cleaning plant is also installed of a capacity sufficient to operate 12 sweepers simultaneously while still maintaining a vacuum of 12 in. at the pump.

Apparatus	No.	1, 32,000 C. F. M.	capacity for the Senate.
"	"	3, 38,000 C. F. M.	capacity for the House.
"	"	5, 16,000 C. F. M.	capacity for library section.

The Difficulty of Measuring Heat

WITH SPECIAL REFERENCE TO RADIATED AND CONVECTED HEAT.

BY A. H. BARKER, B. SC. AND F. C. S. BRENDAL, B. SC.

(From a lecture delivered at University College, London.)

The general object of the experiments now under discussion is primarily to develop a method of determining a balance sheet of the heat supplied to a room. I wish to explain in some detail the difficulties of this determination, as it forms a very good and instructive example of the kind of difficulties which are always met with in all accurate experiments in heating and ventilation.

It is well known, of course, that heat is supplied to a room in two forms (1) as convection currents of warmed air; (2) as radiated energy proceeding from the hot object, which is usually but incorrectly called radiant heat. Strictly speaking, radiant energy is not heat at all until it is converted into heat by impinging on an absorbent surface.

The inter-relation between these two totally distinct quantities of energy is exceedingly complicated. In the first the measurement of the absolute magnitudes of the two by any direct method is a very difficult process. Further, these two different kinds of energy are capable of being almost instantaneously transformed from one form to the other.

Thus energy radiated into a room from any kind of hot surface becomes immediately converted into heat, by merely impinging on an absorbing surface in the room. Part of that heat can be almost immediately communicated to the air in contact with the surface, so that energy which leaves the hot object as pure radiation, in the course of two or three seconds, may be converted into a stream of warm air rising from the absorbent surface. Part of the energy may also be radiated back again by reflection or by re-radiation.

It is clear, therefore, that if the relative quantities of radiant energy and convected heat are to be measured with any approach to accuracy, it must be under such conditions that this interchange cannot take place before the measurements are made. In any case, the measurement will be one of no ordinary difficulty, partly because this condition of preventing transformation is almost impossible to carry out completely.

It is all but impossible to carry out in practice the condition of keeping to two quantities of energy quite separate until after they are measured. The failure to effect this results in a vitiation of the observations which, unless care is taken to minimize them, may be so serious as to destroy their value altogether. The importance of these observations to the practical heating engineer is not apparent at first sight. If within a few seconds of leaving the hot surface any radiation can be and is transformed into convection currents, what can be the object of taking great trouble to measure the quantities of energy separately?

RADIANT VS. CONVECTED HEAT.

The answer to this perfectly legitimate criticism is that the sensations produced in a room heated by the two methods are altogether different. We can easily conceive an enclosed room heated altogether by convected currents of warm air, indeed this is one of the standard methods of heating a room. It is not by any means easy to conceive a room heated altogether by radiant heat. In the latter case, apart from the effect of what may be called secondary convection currents, the temperature of the air in the room would be the same as that of the air out of doors. The ventilation of the room would be in this sense perfect, that the composition of the inner room air should be the same as that out of doors. There would be no limit to the amount of air that could on this system be passed through a room. How then could one say that a room is heated at all if this condition is fulfilled.

These matters were fully discussed in the public lecture which I gave at the University College some two years ago, on "The Reading of a Thermometer," in which I explained the difference as I conceived it, between what I called the radiant temperature and the air temperature of the room, and I exhibited instruments we had devised for measuring these two quantities. A room heated entirely or mainly by radiant heat would in cold weather show a relatively high radiant temperature and a relatively low air temperature when measured by these instruments. It is found from observations of these instruments that a method of heating which furnishes a large proportion of its heat in radiant form, secures a high radiant temperature and a feeling of warmth along with a relatively low air temperature and a feeling of freshness.

This, I believe, is the very essence of the problem of satisfactory heating and ventilation. This is the fundamental reason for the importance of this subject, and the reason why this series of experiments were designed when this department was first founded and which we are only now bringing to completion.

ELUSIVENESS OF RADIANT HEAT.

One other reason emphasises the importance of this subject. Energy in radiant form may easily pass through a room in large quantities without warming it at all. A large part of it may pass away through the window glass or be absorbed by a very cold wall only producing a very slight effect on a shielded thermometer in the room, yet the room may feel warm to a person in it so long as the radiant supply of energy continues. It is evident that in making the attempt to analyse the conditions that make up satisfactory heating, the very first step is to develop satisfactory methods of measurement of the quantities of the two kinds of energy employed, and these methods will shortly be described.

Before considering the determination of the radiant energy in detail, we ought first to remember the elementary laws governing that form of energy so far as they are applicable to the case in point. The first is that all bodies at whatever temperature are continually emitting radiant energy proportional in amount to the fourth power of the absolute temperature of their surfaces. When we speak of a certain amount of radiant energy from one hot body impinging on and being absorbed by another cooler body, we are alluding to the difference between the amount emitted by the hot body and absorbed by the cooler body on the one hand and on the other the energy simultaneously emitted by the cool body. The net amount received by the cool body due to the proximity of the hot body, is conveniently spoken of as the radiant energy received, although it is not exactly an accurate way of speaking.

ADVANTAGES OF ELECTRIC RADIATORS FOR TESTING PURPOSES.

Further, we know that when radiant energy proceeds from one point, its intensity at any given distance varies inversely as the square of the distance from the point. When a larger surface than a point emits the energy this law is not strictly obeyed, but in all practical cases it is near enough for our purposes. To repeat, the primary object of these experiments is to ascertain in regard to different methods of heating, what proportion of the total amounts of energy employed is used as radiant heat, and what proportion as convection currents. Of all the different methods of heating, the easiest to test on this basis is the electrical radiator, essentially because electrical measurements are easy. It is easy to determine the total quantity of electrical energy consumed by any appliance whatever by measuring the current and the voltage between terminals. Thus we know with certainty that every electrical heater of whatever kind and however bad it may be, at least converts into heat 100 per cent. of the energy consumed, neither more nor less. In this sense no electrical heater can be more or less efficient than any other. The only problem in the case of the electrical heater is how much of this energy becomes radiant and how much convected.

The case of a water or steam radiator is similar, in that we can ascertain by direct observation how much energy comes into the room altogether. In the case of a water radiator, we have to take the quantity of water passing through the radiator in one hour and multiply the difference of temperature at inlet and outlet. This is a much more difficult and tedious operation than reading an ammeter and a voltmeter.

With such a device as an open fire or a gas fire, we do not even know how much of the energy consumed is converted into heat in the room itself. This measurement is much more difficult still, because we do not get into the room the whole of the energy consumed except in the case of the monstrosities known as "gas radiators."

In the case of an open coal fire, we require at least the following measurements in order to determine the total quantity received in the room itself before we can commence to measure how much of the quantity received is convected and how much radiated:

(1) The exact quantity of coal burned and rate of burning at any given moment.

(2) The exact calorific value of the fuel per pound.

(3) The amount of heat lost to the room in the flue gases.

Each of these determinations presents considerable difficulties, and the net result could only be accurate if each individual observation were accurate. Similar observations would have to be made in the case of a gas fire in order to obtain the total energy employed. This would, of course, as in the coal fire, be the difference between the total energy in the gas, and the total quantity thrown away in the flue gases. The case of water or steam radiators is in practice almost as difficult. It involves simultaneous observations on the quantity of water flowing through the radiator, the difference of temperature between flow and return, and it would involve the keeping of all these factors quite constant during the experiment.

With an electrical stove with which we are chiefly concerned tonight, the gross energy is also the net energy brought into the problem. There is nothing to be al-

lowed for heat lost in the flue gases, because there are no flue gases. Although, however, the observations in the case of the electrical radiator are easiest, they are certainly, so far as the practical heating engineer is concerned, less important than almost any other forms of heating, because owing to the high cost of electrical energy at the present time, it is much less frequently employed than is the case with the other forms of heating with which we have to do.

MEASURING RADIANT ENERGY.

The obvious method of measuring the amount of radiant energy passing through any given square foot of space is to allow the radiant energy to impinge normally on a black absorbent surface of carefully measured size, the surface being of such a character that the amount of heat communicated to it can be readily measured. This will absorb the whole of the radiant energy impinging on it and convert it into heat. Such a service is provided by the apparatus known as Smith's radiometer. It consists of a single coil of square section pipe through which water is allowed to flow, formed into a square foot of flat surface. The quantity of water flowing through the coil per hour multiplied by the difference of temperature between the water entering and leaving the coil represents the total amount of energy gained by the coil per hour converted into thermal units.

The drawback to this method is its extreme tediousness. To make one single observation occupied perhaps half an hour. There are further corrections to be made for the following reason: What is actually measured by this radiometer is the total quantity of heat which the surface receives from all sources. That heat may be communicated not only by the absorption of radiant energy, but also by the contact of air.

If therefore the temperature of the water in the coil is in any degree different from that of the surrounding air a change in temperature will be produced in the water passing through the coil, even when no net radiant energy is impinging on it. In order to correct for this possible source of error, there are two practical methods: (1) so to adjust the temperature of the water that the entering temperature is as much lower than the surrounding temperature as the leaving temperature is higher, that is to say, to make the mean temperature of the water in the coil the same as that of the surrounding air. This method, however, is highly inconvenient, as it involves a great deal of adjustment.

The second method is to make a correction by continuing the experiment on the radiometer after the source of radiant heat is withdrawn, and so to determine what may be called the co-efficient of transmission for the radiometer. Then ascertain by calculation what is the total amount of heat lost or gained by the radiometer per degree difference of temperature between the air and the coil, and add or subtract this to or from the result of the other observation.

All these manipulations with the radiometer are excessively tedious, and some more much rapid method is desirable whereby a long series of readings can be taken in a brief space of time. Such a method is at hand in the thermopile, which is an instrument well known but little used by the physicists.

(*To be continued.*)

How Radiant Heat from Gas Radiators is Determined

In discussing the use of gas radiators for heating churches, offices, restaurants, or similar rooms during periods of relatively mild weather, at the recent annual meeting of the American Society of Heating and Ventilating Engineers, George S. Barrows, a member of the Committee on the Utilization of Gas Appliances of the American Gas Institute, was asked how the efficiency of a gas radiator was determined, and what 100 per cent. efficiency would mean.

Replying to this inquiry, Mr. Barrows stated that 100 per cent. efficiency would mean the utilization for heating purposes, of all the energy in the gas. Any properly designed gas burner will give perfect combustion, that is, all of the

energy in the gas available in the form of heat will be delivered to the room. This will mean 100 per cent. of the energy is liberated in the room, but does not mean this energy is utilized in the best manner for heating the room or the persons therein.

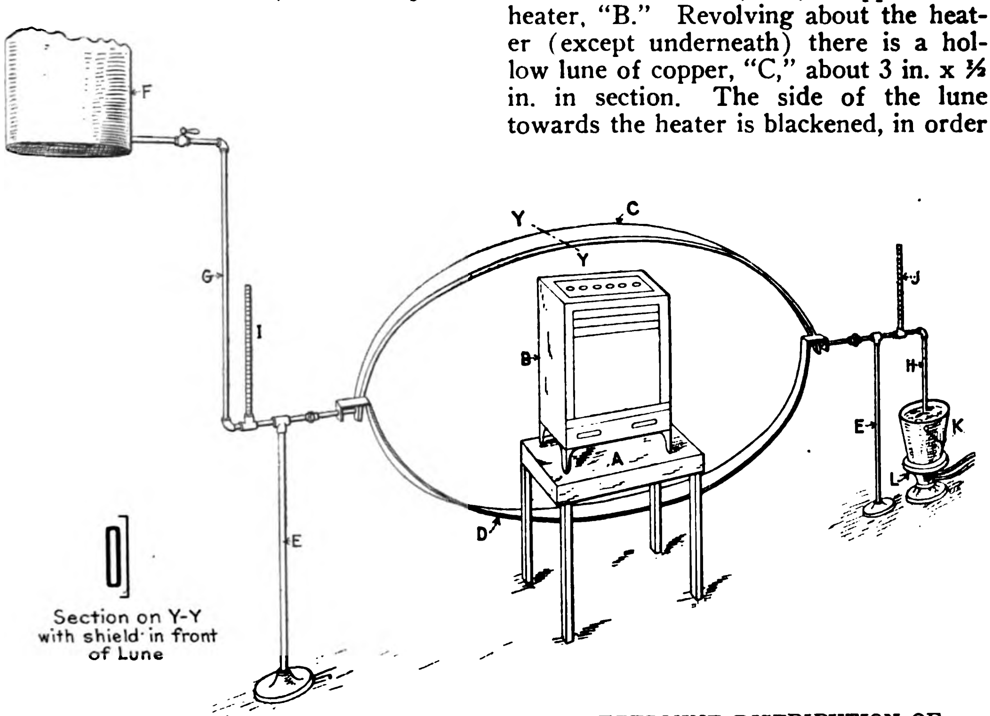
The value of the heater will be governed entirely by the method in which the heat generated is utilized. For instance, if a room is a high one with many windows or thin walls, in an exposed situation, most of the heat is delivered from the heater in the form of heat of convection. This heat will rise, and because it will be rapidly dissipated after heating the walls and ceiling, the practical efficiency of the heater will be small.

If, on the contrary, the heater delivers most of its energy in the form of radiant heat, and it is placed in a location central to the position of most of the occupants of the room, then its practical efficiency will be high.

For the purpose of studying the effect of various heaters, a series of tests has been inaugurated to plot the distribution of radiant heat and hot air convection currents. Unfortunately, other matters of more pressing importance have prevented the carrying of these tests to their conclusion, and no work has been done on the study of convection currents. Some work has been done on the distribution of radiant heat.

To measure this heat, a special form of calorimeter was devised, and a diagrammatic sketch of this piece of apparatus is appended.

A wooden stand, "A," supports the heater, "B." Revolving about the heater (except underneath) there is a hollow lune of copper, "C," about 3 in. x ½ in. in section. The side of the lune towards the heater is blackened, in order to absorb as large a proportion as possible of the radiant energy which falls on it.



ARRANGEMENT OF TESTING APPARATUS TO DETERMINE DISTRIBUTION OF RADIANT HEAT AND HOT AIR CONVECTION FROM A GAS RADIATOR.

A shield, "D," of bright tin is arranged on the same axes as the axes of the lune, and is used for shielding the lune from the radiation as will be described further on.

The lune and its shield are supported on the stands, "E," by means of the pipe axes, "G" and "H." "G" leads from the water supply "F," and "H" is an outlet to a bucket, "K," on the pan of a scale, "L." The thermometer, "I" and "J," give the temperatures of the inlet and outlet water.

To operate, the heater is lighted and allowed to burn until it has reached a uniform temperature. Water is then allowed to flow from the tank through the lune. The lune is set in any desired position above the heater, horizontally opposite the center of it, or at any angle, and the rise in temperature of the water through the lune is observed by means of the two thermometers, the water being weighed to determine the number of heat units absorbed with that particular position of the lune.

The rise in temperature of the water shows the total amount of heat, both radiant and convected, that is absorbed by the water in passing through the lune.

The shield is then turned so that it is between the heater and the lune, and other readings in the rise of the temperature of the water are noted. As the shield intercepts most of the radiant heat, the rise in temperature of the water in this case is only due to the heat of convection.

Subtracting the heat units absorbed by the water from the heat of convection, from the total heat units absorbed by the water, will give the heat units absorbed from the radiant heat.

By moving the lune into a number of different positions, the distribution of the radiant heat is obtained.

The Work of the Chicago Ventilation Commission

Through the publication of a report covering the activities of the Chicago Commission on Ventilation from the date of its organization in 1910 to date, many details of the commission's investigations are made public, in addition to those already published. Included in the report are tests made by the commission on the ventilation of passenger cars, picture theatres, an experimental school room and with an experimental cabinet. The opinions of the commission on phases of ventilation are set forth in resolutions.

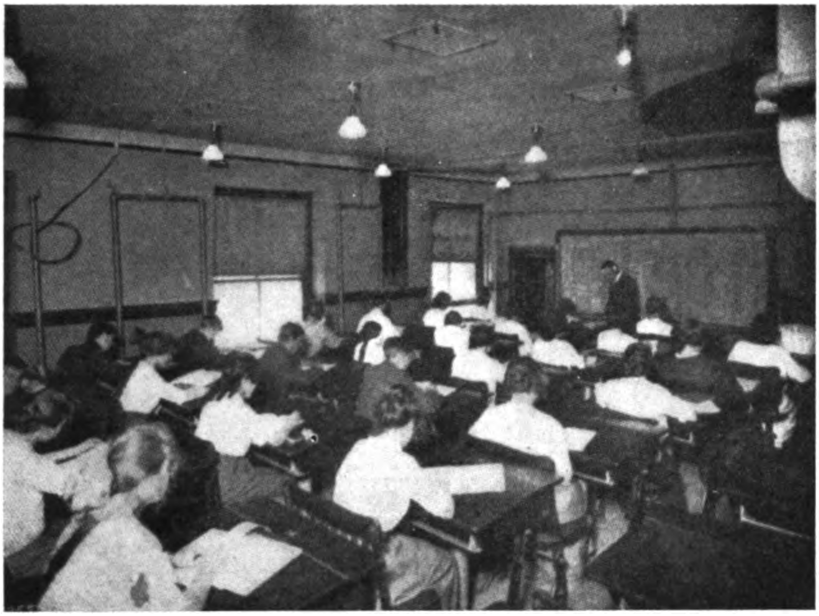
One of the most important experiments was that made in an experimental school room, which has already been described in our columns. This room, it will be recalled, was especially fitted up as an experimental room. An airtight falsefloor was built about 18 inches above the regular floor of the room and a false ceiling was hung about 8 inches below the room ceiling. The results of experiments made under these conditions were presented in detail in THE HEATING AND VENTILATING MAGAZINE for December, 1913.

THE COMMISSION'S LATEST INSTALLATION.

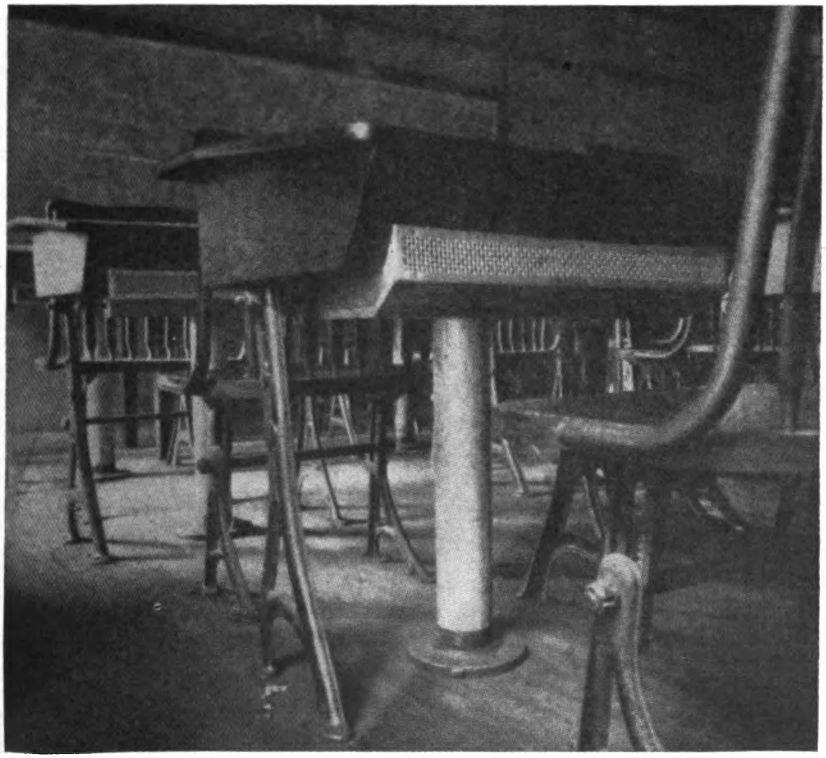
The report states that the commission's first attempt at insuring an equitable distribution of air for ventilation purposes within the experimental room led to a more permanent installation. In the new installation the heating of the experimental room has been separated from the ventilating, in so far as they seem to impair the efficiency of each other. The scheme in brief consists in bringing the air for ventilating purposes into the room through galvanized iron ducts insulated with asbestos and located under the false floor. This system of ducts terminates in 3-in. iron pipes securely fastened to the floor and leading up under the desks. The room is heated by means of hot air driven under the floor. The idea in this scheme is to warm the floor. In order to reduce the effect of window chill, double windows are to be installed, and the heated air from under the floor will be forced upward between the two sets of windows and thus effectually overcome window chill. As in the older installation, the air comes in below the desks and leaves the room through twelve registers in the false ceiling. The air used for ventilating, being introduced through separate insulated ducts, may be at a much lower temperature than that of the air used for heating.

TEST OF AIR CONDITIONS IN OFFICE BUILDING.

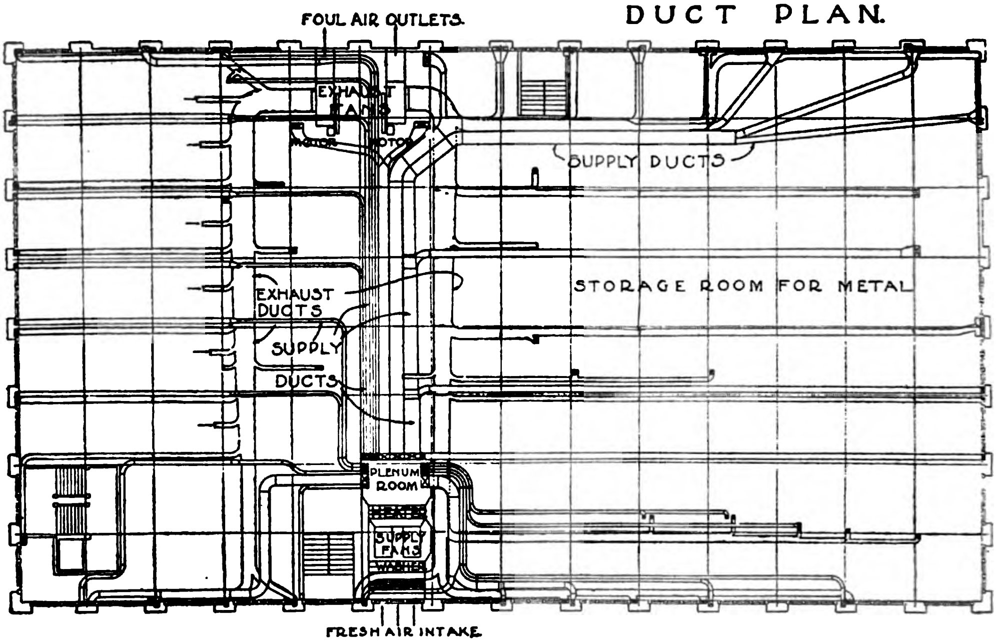
Another test reported by the commission was made April 9, 1914, at the office of Joseph T. Ryerson & Son, in Chicago. This consists of a general office, covering the top (third) floor of the building. It is one large room, with a



EXPERIMENTAL SCHOOL ROOM IN CHICAGO NORMAL COLLEGE.



DESK IN EXPERIMENTAL SCHOOL ROOM, SHOWING INDIVIDUAL AIR SUPPLY.



DUCTS AND APPARATUS UNDER FLOOR OF OFFICE OF JOSEPH T. RYERSON & SON, CHICAGO.

few adjacent small private offices. The large room has many low partitions, counters, etc. The ceiling is largely of glass, under a sawtooth type skylight. There are normally about 235 occupants.

The system of heating is entirely indirect steam, with both supply and exhaust fans, with air washer and automatic temperature control. The system of ventilation is described as "by dilution." The inlet openings are about 8 ft. above the floor on the outside walls, averaging about 20 ft. apart. The outlet openings are at the floor, in the outside walls and parallel with the inlet openings. Sheet metal ducts connect the various supply and exhaust flues with the fans, being run along the ceiling of the partially heated metal warehouse under the office.

The supply fans consist of two double wide, double inlet, full-housed 8-blade fans, changed, evidently after the original installation, by adding 8 blades about 6 in. wide alternating with the original blades. The fan wheels are 42 in. in diameter and about 42 in. wide at the periphery. Both are on the same shaft and are operated at 292 R.P.M. Were they of the 8-blade type, they should deliver 22,000 cu. ft. of air per minute at this speed. They are delivering, by anemometer test of the tempered air which they handle, about 27,000 C.F.M. This increase is accounted for by the extra blades. The fans are belt driven by a 15-horsepower motor. The exhaust fans have a rated capacity of about 80 per cent. of the capacity of the supply fans and discharge the air exhausted from the office into a storage shed.

Cold air is drawn from three windows, each 4 ft. by 4 ft. 6 in., about 30 ft. above the street. The room inlet openings have horizontal blade diffusers installed by the owner after having had experience with cold drafts. The outlet openings from the rooms are in the side walls. Many are obstructed by furniture. There is no provision for any air removal at or near the ceiling.

The heater is made up of eight rows of 1-in. pipe, controlled by diaphragm (thermostatic) valves, between the air washer and the intake. There are also twelve rows of 1-in. pipe, automatically controlled, between the air washer and the fan. The free area for air passage is 29.2 sq. ft. The total surface is 2,500 sq. ft.

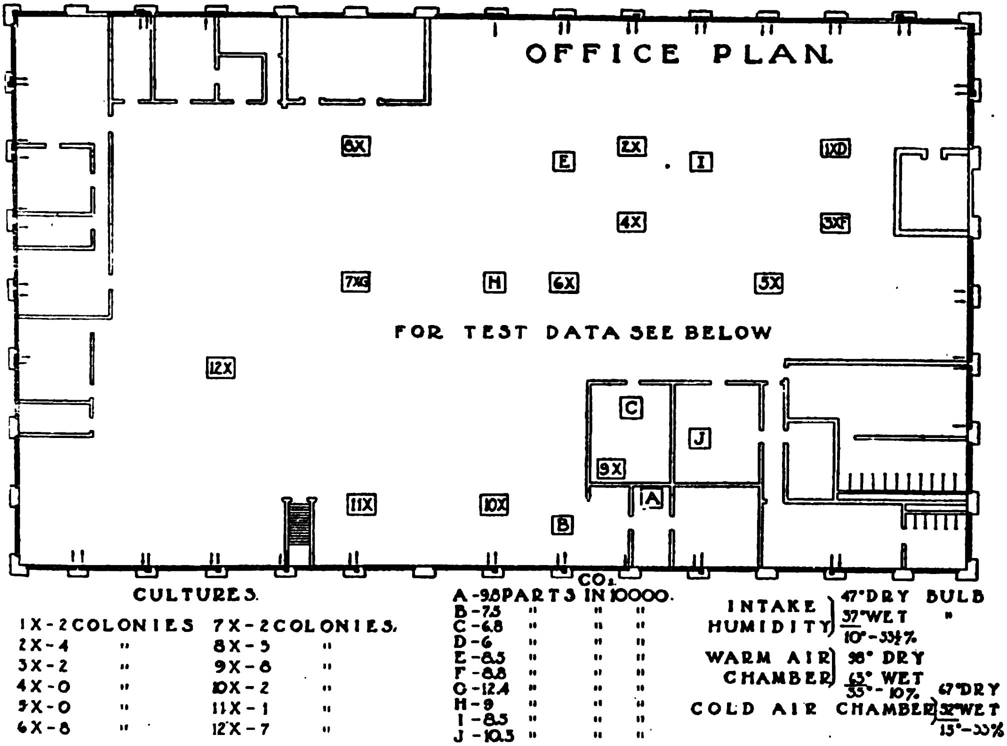
The air washer installed is of the multiple spray type, with automatic water line governor and electric-driven belted centrifugal pump. The iliminators are vertical. No humidity control or means of heating the water is provided. The water was very dirty. The eliminator was coated with dry deposit, 1/8 to 1/2 in. deep. The washer is 13 ft. wide, 6 ft. high, and 5 ft. paralleling the direction of the air passage.

Ducts are of sheet metal, have very long runs, and are figured for 800 to 1,500 lin. ft. per minute velocity. They are not insulated from each other or from the surrounding air, which often gets as low as 30° F. As the ducts are rather minutely subdivided, with separate automatic mixing dampers in each, the skin friction is considerable.

There are no heating coils between the air washer and the fan, and the tempered air used for cooling the office evidently is often insufficiently heated. By means of double dampers and a complicated series of baffles between the tempered air and hot air chambers, an attempt has been made to warm the tempered air by forcing hot air to mix with it, under thermostatic control.

DETAILS OF TEST.

Time of test, 2 to 5 P. M.
Outside air, 37° F.
At air washer, 46° F.
Air washer water, 46° F.
Hot air chamber, 98° F.
Tempered air chamber, 67° F.
In the office, average, 72.2°, ranging from 68° to 76° F.
Relative humidity outside, 33.5%.
Average in the office, 38.4%, ranging from 26% up to 50%.



MAIN FLOOR PLAN, OFFICE OF JOSEPH T. RYERSON & SON, CHICAGO.

BACTERIA.

Petrie dishes were exposed for two minutes each at the points marked "1X, 2X," etc., on the plans, with the results

shown on the margin, following the index numbers.

AIR DISTRIBUTION.

A. Samples of the air were taken at the points marked "A, B," etc., on the plans, with the results shown on the margin, following the index numbers. The outside CO_2 at the beginning of the tests was 3.8 parts per 10,000.

B. Ammonium chloride formed from the combination of ammonia and hydrochloric acid was introduced into the plenum chamber, to visualize the air distribution.

DUST.

The dust content in the entering air at the supply windows was 5,600,000 per cubic centimeter. Between the washer and the fans it was 4,000,000 per cubic centimeter. In the office, it was 1,600,000 as tested at two representative points.

The plant has been in use about five years. The tempering coils, being exposed to the weather, are very rusty. Several pipes, having frozen, are blanked off. The washer is very dirty.

The fan wheels and housings are covered with oil and dust averaging ¼ in. deep. The plenum chamber and ducts are very rusty. The plant otherwise is in good order. There is considerable discoloration of the walls around the room intakes. The neighborhood of the plant is smoky and dirty.

The average relative humidity was lower than would be desirable, and if an average of 45% had been maintained, greater comfort and a lower temperature would be possible.

The bacteria colonies were very low in number, indicating excellent cleaning in the room, and an ability in the plant to maintain a high efficiency in this regard.

The carbon dioxide analysis indicates a very poor fresh air distribution, as where it showed by this index 12 parts of CO_2 per 10,000 only 750 cu. ft. of air per hour per occupant were being delivered in such localities. For the whole room nearly 6,900 cu. ft. of air per hour per occupant are really delivered.

The air distribution test showed that the greater part of the fresh air supply is being delivered to the north side of the room. The adjustment of the volume dampers which effected this evidently was made in order to warm the room in cold weather, this being especially necessary since the heating plant is on the south, and the supply ducts are run long distances in a very cold place without insulation.

The high dust content at the inlet and the low dust count in the room are striking, especially as the air washer seems to have an efficiency of but 28%.

It may be accounted for by the disturbance of local settled-out dust in the intake and fan rooms by the operatives of the instruments and by the fact that much of the dust so stirred up settled in the fans and ducts before reaching the room.

CONCLUSIONS OF THE COMMISSION.

The owner evidently made and is making a conscientious endeavor to provide the best possible working conditions. The provision of some direct radiation along the north side, or indirect ratiator boosters in the ducts running to the north side, by enabling the room to be heated evenly would permit of a more perfect air distribution, correcting the condition indicated by the CO_2 and air distribution tests. The trouble would be ameliorated by heating the room under the office, or by insulating the ducts.

The supply fans are running very slowly in consideration of the length of the ducts and there is ample power to speed them up to at least 350 R. P. M. The entire air handling mechanism should be thoroughly cleaned at frequent intervals.

The installation of automatic humidity control is not difficult, and would improve the conditions.

The closing of the inlet openings on one side of the room and the closing of all vent openings on the opposite side is suggested for use in warm weather especially, as it is believed that such a procedure would insure a more thorough sweeping with fresh air of the entire area.

For hot weather operation, it would probably be an improvement if ceiling outlets were provided, whereby the hot air accumulating there by reason of the sun effect could be forced directly out by the incoming cooler air.

A similar new plant should be so de-

signed that there will be no long ducts run in cold air, especially to the north side. It should have its vertical flues thoroughly insulated, especially if they must run up outside walls. It should have both floor and ceiling inlets and outlets so that efficient summer operation may be effected.

The various instruments used in this test are described in the report.

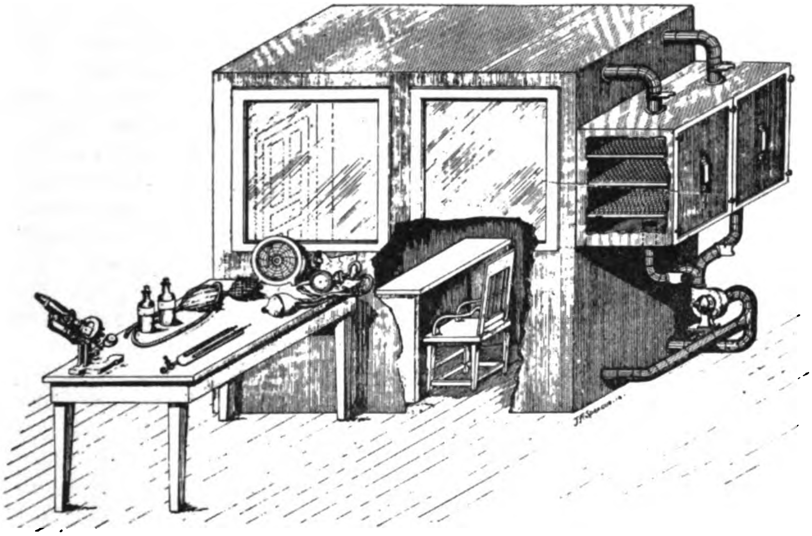
CABINET TESTS.

The accompanying illustration shows the cabinet used by the commission in its cabinet tests. The tests were conducted under varying air conditions, with particular reference to volume, movement temperature, humidity, carbon dioxide, dust and bacteria. It is the intention to repeat the tests with subjects of different types. Thus far the tests have been only of a preliminary nature, to enable the commission to determine the best method of conducting them, and also to determine the best apparatus required to maintain the desired atmospheric conditions.

The cabinet is built of heavy galvanized iron, 28 in. wide, 6 ft. long, and 6 ft. high. All seams are soldered and painted. On one side are two observation windows, each 2 ft. square. At one end is an airtight door, and at the other end is a three-speed direct-connected Sirocco fan, having a maximum capacity of 84 C. F. M. The installation of the fan is such that the air may be re-circulated in the cabinet, or fresh air introduced. The fan discharges the air into the cabinet through either or both of two compartments in which chemicals or other material may be placed for controlling the temperature, humidity, CO_2, etc. In addition to the above a small air washer is about to be installed.

The cabinet easily accommodates two persons. The tests are usually conducted with two subjects of different age and type, at the same time, in order to obtain a check on the effects noted.

Observations are taken, at stated periods throughout the tests, of the air conditions as well as the physical and mental condition of the subjects.



TEST CABINET USED BY THE CHICAGO COMMISSION ON VENTILATION.

The Chicago Commission on Ventilation, as now constituted, is composed of George B. Young, M. D., and E. V. Hill, M. D., representing the Chicago Department of Health; John Wilkes Shepherd, representing the Chicago Board of Education; Samuel R. Lewis, James H. Davis and H. M. Hart, representing the Illinois Chapter of the American Society of Heating and Ventilating Engineers; George Beaumont, representing the Illinois Chapter of the American Institute of Architects; Meyer J. Sturm, representing the Illinois Society of Architects, and Fred J. Postel, representing the Western Society of Engineers.

The Performance and Selection of Centrifugal Fans

DATA AND NOTES APPLYING TO BOTH STEEL AND MULTIVANE TYES.

BY THE LATE FRANK L. BUSEY.

(From a Paper Presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York, January 20-22, 1915.)

II.—FAN SELECTION.

It has been the custom until recently for the fan builders to issue capacity tables of their fans based on total pressure and giving the fan performance at its rated point—that is, the point of highest total efficiency. The growing custom of specifying static resistance has led to the publication of static pressure capacity tables for many of the fans now on the market, and in some cases these tables are arranged to give the fan performance at other than its rated point. Such tables have been issued for the Sirocco and for the Niagara Conoidal fans. As these tables may apear somewhat puzzling to one not familiar with their use, a brief explanation of their application in the selection of a fan may prove of interest.

The sample capacity tables here shown are taken from the tables of the Niagara Conoidal fan, and are based on the performance curves shown in Figs. 6 and 7. Table II is a reproduction of what might be termed the rated capacity table, giving the capacity, speed and horsepower of the different sizes for different total pressures, when operating at what has been selected as the rated point on the curves. This is approximately the point of highest efficiency. These tables are similar to practically all of the fan tables heretofore published and require no particular explanation.

Table III is one of a set which, like the recently published tables for the American Sirocco, may at first appear puzzling to one inexperienced in their use. While Table II gave the performance of all sizes at the most efficient point only, this one gives the performance for one size only, but all along the curve on both sides of the most efficient point.

TABLE II.

CAPACITIES OF BUFFALO NIAGARA CONOIDAL FANS (TYPE N) UNDER AVERAGE WORKING CONDITIONS—AT 70° F. AND 29.92 INCHES BAROM

Fan No.	Mean Dia. of Blast Wheel.	Area of Outlet. Sq. Ft	3/8 In Total Press or 0.217 oz			1/2 In. Total Press or 0.288 oz			5/8 In. Total Press. or 0.361 oz.			3/4 In. Total Press. or 0.433 oz.		
			R.P.M.	Vol	H.P.	R.P.M.	Vol	H.P.	R.P.M.	Vol.	H.P	R.P.M.	Vol.	H.P.
3	15⅝	1.31	413	1490	0.13	478	1720	0.19	533	1930	.27	585	2110	0.35
3½	18⅛	1.79	354	2030	0.17	409	2350	0.26	457	2620	0.37	501	2870	0.48
4	20½	2.33	310	2650	0.22	358	3070	0.34	400	3430	0.48	439	3750	0.63
4½	23½	2.96	276	3360	0.28	318	3880	0.43	356	4340	0.60	390	4750	0.80
5	26⅛	3.64	248	4150	0.35	287	4790	0.53	320	5350	0.74	351	5870	0.96
5½	28¾	4.41	225	5020	0.42	260	5800	0.65	291	6470	0.90	319	7100	1.19
6	31⅝	5.25	207	5970	0.50	239	6900	0.77	267	7710	1.07	292	8450	1.41
7	36½	7.14	177	8130	0.68	205	9400	1.05	229	10490	1.46	251	11500	1.92
8	42	9.33	155	10610	0.89	179	12260	1.37	200	13700	1.91	219	15020	2.51
9	47	11.81	138	13450	1.12	159	15520	1.78	178	17340	2.41	195	19000	3.16
10	52	14.58	124	16580	1.39	143	19160	2.14	160	21400	2.96	175	23460	3.93
11	58	17.64	113	20070	1.68	130	23180	2.58	146	25900	3.60	160	28390	4.75
12	63	21.00	104	23880	2.00	119	27590	3.08	133	30820	4.29	146	33780	5.65
13	68	24.65	95	28040	2.35	110	32370	3.61	123	36180	5.03	135	39650	6.63
14	73	28.68	89	32520	2.72	102	37550	4.19	114	41950	5.84	125	43990	7.69
15	78	32.80	83	37330	3.13	96	43100	4.80	107	48160	6.70	117	52790	8.88
16	84	37.32	78	42470	3.56	90	49040	5.47	100	54790	7.62	110	60000	10.1
17	89	42.14	73	47950	4.01	84	55370	6.17	94	61860	8.60	103	67800	11.4
18	94	47.24	69	53750	4.49	80	62000	6.92	89	69340	9.64	98	76010	12.7
19	99	52.63	65	59800	5.00	75	69160	7.71	84	77200	10.8	92	84700	14.2
20	105	58.32	62	66300	5.56	72	76640	8.54	80	85600	11.9	88	93850	15.7

Static pressure is 77½% of total press

TABLE III.

NO 10 NIAGARA CONOIDAL FAN (TYPE N).

Capacities and Static Pressures at 70° F and 29.92 In. Barom

Outlet Velocity Ft.-Min.	Capacity Cu. Ft. Air Per Min	Add For Total Press	½ In. S.P		¾ In. S.P.		1 In. S.P		1½ In. S.P		2 In. S.P.	
			R.P.M.	H.P	R.P.M.	H.P	R.P.M.	H.P	R.P.M.	H.P	R.P.M.	H.P
1400	20410	0.122	**164**	**2.92**	206	4.61	243	6.59	308	11.1		
1500	21870	0.141	163	3.13	204	4.78	240	6.83	305	11.5		
1600	23330	0.160	164	3.42	202	5.02	238	7.06	302	11.8	357	17.0
1700	24790	0.180	165	3.74	**201**	**5.30**	235	7.28	299	12.1	353	17.5
1800	26250	0.202	166	4.13	**200**	**5.61**	233	7.59	296	12.4	350	17.9
1900	27700	0.225	168	4.55	200	6.01	232	7.91	293	12.7	347	18.3
2000	29160	0.250	171	5.04	200	6.48	**231**	**8.32**	201	13.0	343	18.7
2100	30620	0.275	174	5.56	201	7.00	231	8.77	288	13.5	340	19.2
2200	32080	0.302	177	6.12	203	7.54	230	9.31	286	13.9	338	19.6
2300	33540	0.330	180	6.76	205	8.16	231	9.92	285	14.4	336	20.1
2400	34990	0.360	183	7.43	207	8.86	232	10.6	**284**	**15.0**	332	20.6
2600	37910	0.422	190	8.95	213	10.4	235	12.1	282	16.3	329	21.8
2800	40830	0.490	198	10.7	219	12.2	240	13.9	283	18.1	**327**	**23.3**
3000	43740	0.560	206	12.7	226	14.3	246	16.0	285	20.1	326	25.0
3200	46660	0.638	215	14.8	234	16.7	251	18.3	288	22.4	327	27.4

Note· Bold-face figures indicate point of highest static efficiency

164	2.92	201 200	5.30 5.61	231	8.32	284	15.0	327	23.3

There is one point in each pressure column at which the fan will give its best efficiency, indicated on the table by the boldfaced figures. For each pressure there is a certain velocity through the outlet that will give the best efficiency, as for instance, 2,000 velocity for one inch static, and this holds true for all sizes. It may often be a matter of expediency to operate a fan at other than this most efficient point, and we will consider this question more in detail later.

HOW TO USE TABLES

A question frequently asked concerning these tables is how will one find the performance of a fan *at any other than the pressures given in the tables.* When using the regular tables of rated capacities we are accustomed to work directly across the table for each size, and find that for different pressures the speed and capacity vary as the square root of the pressure, and the horsepower as the three-halves power. In the case of these new tables, we cannot work directly across, since each line represents a constant capacity. By working diagonally across the table, that is, by *finding in the capacity column a new air quantity proportioned as the square root of the pressures* and then following across the table to the desired pressure column, we will find the required speed and horsepower.

As an example, we will assume it is desired to handle 31,000 cu. ft. of air per minute at 1¼ in. static and we wish to know the speed and horsepower of a No. 10 fan for this purpose. The table gives the data required at once inch, so we multiply 31,000 by the square root of the ratio of 1 in. to 1¼ in. and find the corresponding capacity when reduced to a one-inch basis to be 27,700 A.P.M. From the table, the speed at one inch will be 232 R.P.M._ and require 7.91 H.P. The speed for the required capacity at 1¼ in. pressure will vary from the above directly as the capacity, and the power as the cube of the capacity. The No. 10 fan will then handle 31,000 A.P.M. against 1¼ in. static at 260 R.P.M. and require 11.1 H.P.

Perhaps the most important function of this new set of tables is to enable one to select different sizes of fans for any desired duty, and to tell at a glance the corresponding speed and horsepower. The table here shown is a composite, giving the performance of three sizes of fans, each operating against a static resistance of one inch. As mentioned before, when operating at one inch static the highest static efficiency will be attained with an outlet velocity of 2,000 ft. per minute.

These outlet velocities tend to aid in the selection of a fan, inasmuch as it is good practice to use certain velocities with installations of different character Thus in the case of schools, where quiet

operation is absolutely essential, an outlet velocity of from 1,800 to 2,200 should be used. As the static resistance of such an installation will seldom run over one inch, we note that this is also the point of highest efficiency. In the case of a shop where some noise is not so objectionable, where high duct velocities will be used, and where the static resistance will probably approach two inches, an outlet velocity of perhaps anywhere between 2,800 and 3,400 may be used. For special cases we may use either higher or lower velocities, according to the requirements to be met. But for schoolhouse work one would seldom be warranted in using over 2,200 outlet velocity. By a comparison of the three sets of data in Table IV, it will be seen how we may select either one of the three fans for the same duty. Assuming that we are required to supply 15,000 cu. ft. of air per minute at one inch static, the bold-face figures show that we may use the No. 6 at 400 R.P.M.; the No. 7 at 330 R.P.M.; or the No. 8 at 298 R.P.M. The No. 7 will come the nearest to the most efficient point, requiring less power than either of the others.

In case we expect to use high duct velocities and are interested in first cost rather than economy of operation, the No. 6 would be the fan to use. If low operating cost is the most essential factor to be considered and moderate velocities are allowable, the choice should fall on the No. 7. But in case very low velocities are absolutely necessary, even at a higher initial cost and a slight increase in operating cost, the No. 8 fan should be used.

One of the questions frequently asked by any one using these tables for the first time is how is it that we expect to get two different capacities at the same speed, when we have always been taught that the speed varies as the capacity. As will be seen from the table, each size of fan will deliver two different quantities of air at the same speed with a constant static resistance. But we must also note that the total pressure is different for each case. This means we would be operating at two different points on the performance curve. We have already noticed from Fig. 8 that one of the peculiar features of the pressure curve of this fan is what we might call the hump, or high spot. Now this curve was drawn for a varying capacity but a constant speed, so that over a certain range there will be two capacities for the same speed and pressure, hence the two capacities in the table.

Perhaps the simplest way to illustrate this point would be to show that each installation has a certain definite coefficient of resistance and that the quantity of air handled is a direct function of this coefficient and the static resistance of the system. As shown in Fig. 9, the relations holding in the case of a fan

TABLE IV.—SPEED AND HORSE-POWER OF NIAGARA CONOIDAL FANS, AT VARIOUS CAPACITIES AND ONE INCH STATIC PRESS.

Outlet Velocity Ft.-Min.	Add Total for Press. Inches	No. 6 Capacity, Cu. Ft-Min.	No. 6 R.P.M.	No. 6 H.P.	No. 7 Capacity, Cu. Ft-Min.	No. 7 R.P.M.	No. 7 H.P.	No. 8 Capacity, Cu. Ft-Min.	No. 8 R.P.M.	No. 8 H.P.
1600	0.160	8400	397	2.54	11430	340	3.46	**14930**	**298**	**4.51**
1700	0.180	8920	392	2.62	12150	336	3.57	15860	294	4.66
1800	0.202	9450	389	2.73	12860	333	3.72	16800	291	4.86
1900	0.225	9970	387	2.85	13570	332	3.88	17730	290	5.06
2000	0.250	10500	385	3.00	14290	330	4.08	18660	289	5.33
2100	0.275	11030	385	3.16	**15000**	**330**	**4.30**	19600	289	5.61
2200	0.302	11550	384	3.35	15720	329	4.56	20530	288	5.96
2300	0.330	12070	385	3.57	16430	330	4.86	21460	289	6.35
2400	0.360	12600	387	3.82	17150	332	5.19	22400	290	6.78
2500	0.390	13120	389	4.10	17860	333	5.59	23330	291	7.30
2600	0.422	13650	392	4.36	18580	336	5.93	24260	294	7.74
2800	0.489	**14700**	**400**	**5.00**	20000	343	6.81	26130	300	8.90
3000	0.560	15750	410	5.76	21430	352	7.84	28000	308	10.2
3200	0.638	16790	419	6.59	22860	359	8.97	29860	314	11.7
3400	0.721	17850	432	7.60	24290	370	10.3	31720	324	13.5

NOTE—Bold figures indicate point of highest static efficiency at 1-inch static press.

are directly comparable to those with which we are familiar in the case of electricity. We have, first, the relation of voltage drop or voltage resistance across the terminals is equal to I^2, a measure of quantity, times R, the coefficient of resistance, this product being known as the I^2R loss. In the same way, we have the static resistance on the fan which is equal to the square of the air quantity times the coefficient of resistance of the system. By simply changing the position of the factors in this equation we have *the coefficient of resistance of any system is equal to the static pressure divided by the square of the air quantity.* Also the air handled will be a definite fixed quantity, equal to the square root of the static pressure divided by the coefficient of the system. The static pressure is a constant for any certain installation, being a measure of the static resistance against which the fan is to operate. Thus the static resistance on a fan drawing through six sections of Buffalo Standard Pipe Heater would be 0.57 in.

On the diagram, Fig. 9, are drawn two curves representing the coefficient of resistance of two different installations. The horizontal curves represent the static pressure curves for two different speeds. The points of intersection of each diagonal with the horizontal curves indicate what will be the performance of the fan at either speed for either of the two installations. That is, with a coefficient of R_1 and a speed of 235 R.P.M. the fan will deliver 24,800 cu. ft. of air per minute against one inch static, and it will not deliver any other quantity. If a different installation is considered with coefficient R_2, this same fan will deliver 34,200 cu. ft. of air per minute against one inch static, with the same speed of 235 R.P.M. *That is, each fan will deliver, within certain limits, two air quantities at the same speed and static pressure, but not on the same installation.* If we increase the air quantity we increase the velocity and consequently the friction and static resistance. We have changed the conditions of our system and will have a different coefficient R, with the result that we will operate at a different point on the performance curve.

We note that with a constant coefficient, as for instance R_1, if it is desired to handle more air it is necessary to operate at a higher pressure. Thus, if we speed up to 286 R.P.M., we will develop a static pressure of 1.5 in. and deliver 30,100 cu. ft. of air per minute. The ratio of this new static pressure to the square of the air quantity is still the same as that for the first case. That is, the value of R_1 is the same.

CONCLUSIONS.

The practice of specifying the static resistance against which a fan is to operate and then selecting a fan that will give a high static pressure at the fan outlet and a high static efficiency is to be commended. Where only the total efficiency of a fan is given, but the ratio of the static to the total pressure is known, the static efficiency may be calculated by multiplying the total efficiency by the ratio of the pressures.

As has been mentioned before, in making the selection of a fan the choice lies between the older type of straight blade fan, and the newer multivane type. The impression has of late been prevalent among engineers that the multiblade type is inherently more efficient than the straight blade fan, but we have seen that such is not necessarily the case. A properly designed radial vane fan may be made to give even higher efficiencies than can be obtained with a multiblade type, but as already shown such a fan will be much larger in diameter and narrower.

The real advantage of the multiblade type is the attainment of fairly high efficiency in a more limited space, which makes it of great commercial value for certain classes of work. In case an increasing pressure is designed with an increasing resistance, it has been shown from the pressure curves that the forward curved type is not applicable unless operated beyond its most economical point. On the other hand, it is frequently desired to maintain a constant or increasing pressure with an increase in capacity. In such cases the forward curved type is the only fan capable of accomplishing the desired results. Another important advantage of the multiblade fan is the fact that its higher speed makes it more suitable for direct connection to motors, or at least gives better pulley ratios than may be obtained with radial blade fans.

District Heating

By S. MORGAN BUSHNELL and FRED B. ORR.

RELATION BETWEEN HEAT LOAD AND ELECTRIC LOAD IN BUILDINGS, AND SALE OF HEATING SERVICE.

This series of articles commenced in the January, 1915, issue.

Perhaps there is no question connected with the production of light, heat and power on which there has been expressed more difference of opinion than on the subject of the relation between heat load and electric load in buildings.

For the past twenty-five years and, in fact, ever since the installation of electric lighting plants in private buildings, the extent of the economy gained by using the exhaust steam from the engines for heating the building has been an interesting subject of discussion. Some have claimed that the steam required for heating buildings could be passed through a dynamo and utilized for light and power, thereby making the heat cost a nominal one. Others ignore the fact that low-pressure steam requires nearly as much coal for its production as is required by high-pressure steam and claim that the saving is very small, basing their argument on the fact that it would require from 80 to 100 lbs. pressure to operate the dynamo whereas it would only require about 2 lbs. pressure to heat the building. Many debates have been heard on this subject, each side basing their arguments on various instances which they thought tended to establish their case. Since in most private plants the steam from the boiler flows not only into the high-pressure pipe which delivers the steam to the engines, but also through a reducing valve into a low-pressure pipe which supplies steam for the heating system, and inasmuch as for a long time there were no accurate data available, the question was regarded by many as one of those subjects which, like politics and religion, are often decided more by the natural attitude of the individual than on the basis of demonstrated facts.

While it has been known for a long time that outside temperatures in the morning are usually colder than in the afternoon, and, on the other hand, that the power and lighting requirements are likely to be heaviest in the latter part of the afternoon, it has been impossible to show how far this lack of correlation of heat and electrical demands would affect the result. One of the first attempts to give a rational solution of this problem was included in a paper given by Mr. David Boyden, early in the year 1912, before the American Society of Heating and Ventilating Engineers, in which he took up in a general way the relation between the steam requirements and the electrical requirements of a large department store in Boston. Nearly two years before this, however, some interesting curves were submitted by Mr. A. D. Spencer in connection with central-station systems in Detroit. These curves showed the operation of one of their plants which supplies electricity to the street mains and also supplies exhaust steam to their heating system. They showed that during a large part of the time, electricity had to be supplied to an alternating-current transmission line in order to make the electrical load correspond with the lighting load. In other words, the curves show a large peak in the morning hours caused by the steam requirements, and another peak in the afternoon caused by the electrical requirements. Quoting from Mr. Spencer's paper, we have as follows:

It is further interesting to note in this same report on the cost of using steam in Detroit, that the actual cost per thousand pounds of steam in the station which produces steam only and did not have any electric generating plant was only a very little greater than the cost of producing steam for heat in the station where the steam was also used for providing electrical power. An attempt has been made both in St. Louis and Chicago by the central-station companies in a very small way to generate electricity by isolated plants and feed it into the main central-station system and use the exhaust steam for heating. In order to make this experiment successful, it is

necessary to operate the plants just up to the heat requirements. In other words, the plants feed just enough electricity into the systems to make the lighting load simultaneous with the heat load. This is possible only in cases where there is a large electrical system into which the plants may feed and, while the arrangement helps the showing of efficiency in the plant which furnishes both steam and electricity, the arrangement militates to a certain extent against efficiency in the central-power stations.

RESULTS OF INVESTIGATION BY NATIONAL ELECTRIC LIGHT ASSOCIATION.

In the year 1912 this subject was taken up by the steam committee of the National Electric Light Association. A series of curves was obtained by members of the committee from a number of typical plants. These curves show the actual steam and electrical requirements of those plants on various days during the year. These curves were obtained by measuring the amount of steam used in certain plants which were using central-station service and plotting the steam used in these buildings from the records of the St. John curve-drawing meter. On this same drawing was plotted the simultaneous load curve showing the electrical load required in the same building at different hours of the day.

In order to reduce the electrical curve to its equivalent in steam requirements, it was necessary to assume the number of pounds of steam that would be required per K.W. hour, providing an isolated plant were furnishing this service. The matter was taken up with different engineers and at first it was thought that the ordinary single-expansion engine direct connected to a dynamo would make a unit requiring about 50 lbs. of steam per K.W. hour. In order to make sure, however, this was checked by a number of tests in New York, Chicago and other places in plants of actual operation.

These tests showed a considerably higher average, viz., about 60 lbs. per K.W. hour. In view of the fact that most plants need to operate at night under very light loads, which would mean very low efficiency, and in view of the fact that the average plant is not new, but has been operating a number of years, it was decided that 60 lbs. would be a fair assumption. While it is doubtless true that the efficiency of a small plant would vary from light load to full load, it was not thought best to complicate the problem by trying to compensate for this difference. The average efficiency was assumed as the same throughout the 24 hours.

These investigations have gone a long way towards clearing up the matter under discussion, but there is still room for considerable investigation along these lines. Different buildings vary greatly n their load characteristics. The ordinary high-class theatre giving one or at the most two entertainments per day, would have an entirely different condition from the modern hotel which maintains a very much steadier demand for both light and power. These curves showed that while there was a considerable amount of economy in the use of exhaust steam for heating, the extent of this economy had often been exaggerated. It should be remembered in this connection that these curves show the condition only during the cold weather. During the summer time there, of course, can be no saving, as the premises do not require to be heated, and during the spring and fall the amount of heat required is comparatively small. In order to show the nature of these comparisons, there are shown herewith a number of curves illustrating the relation between the heating and electrical load. These curves include:

Fig. 1 shows the simultaneous steam and electric curve for a large department store in Chicago, on a severe winter day. This store requires a considerable amount of live steam in the summer time for operating a large bank of elevators and for cooking purposes. The steam curve has been determined by various meter readings taken in the summer and the electric curve is therefore superimposed on this steam load. While this introduces a certain amount of estimating in computing the curve, the requirements of the store are pretty well understood and the comparison between the steam and electric curves may be relied upon as practically correct.

Fig. 2 shows the steam load of this particular store on a summer day, also

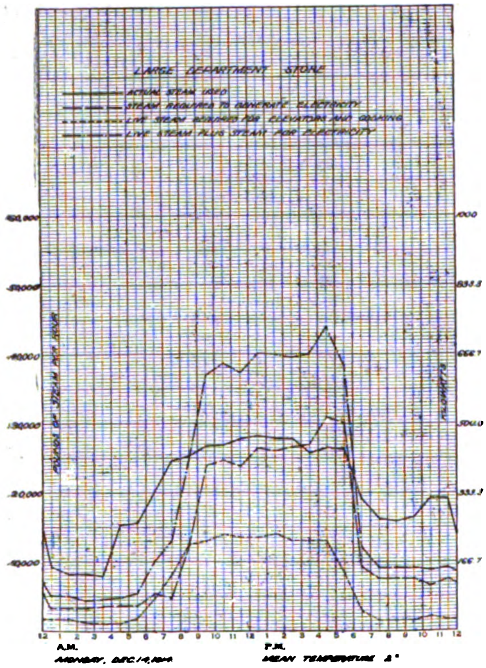


FIG. 1.

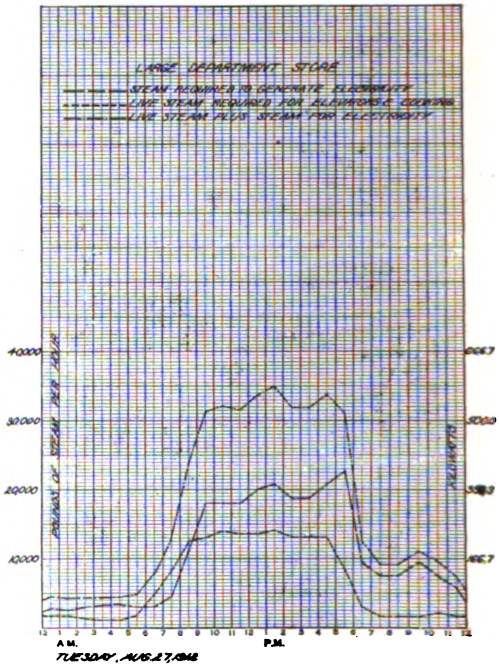


FIG 2.

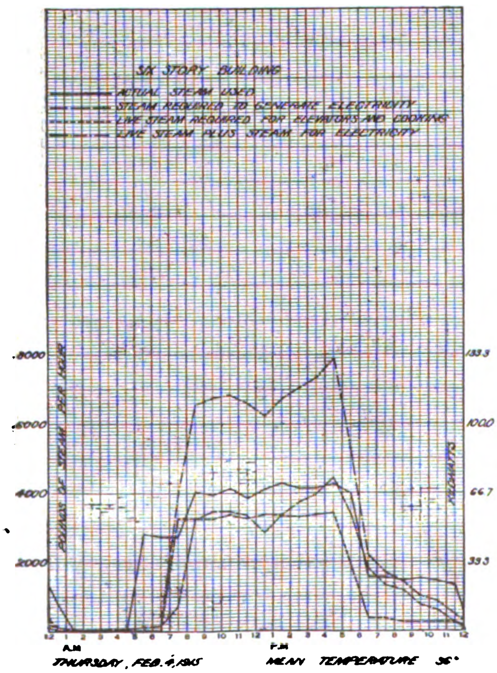


FIG. 3.

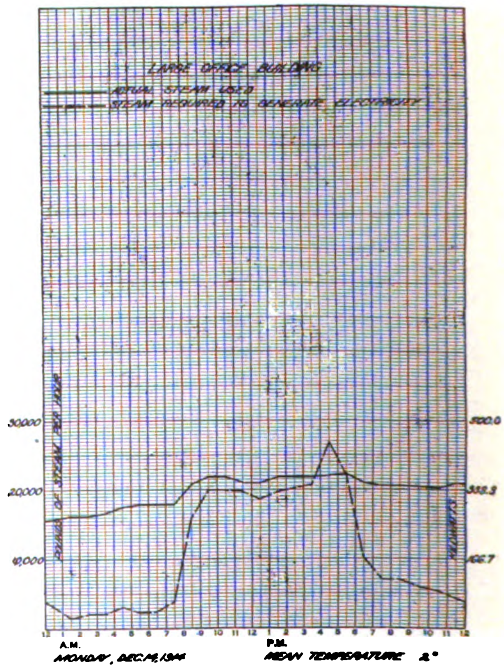


FIG. 4.

LOAD CHARACTERISTICS FOR VARIOUS TYPES OF BUILDINGS.

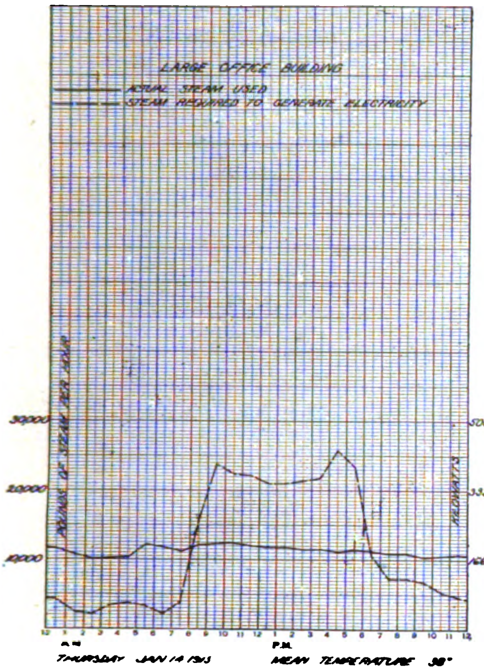


FIG. 5.

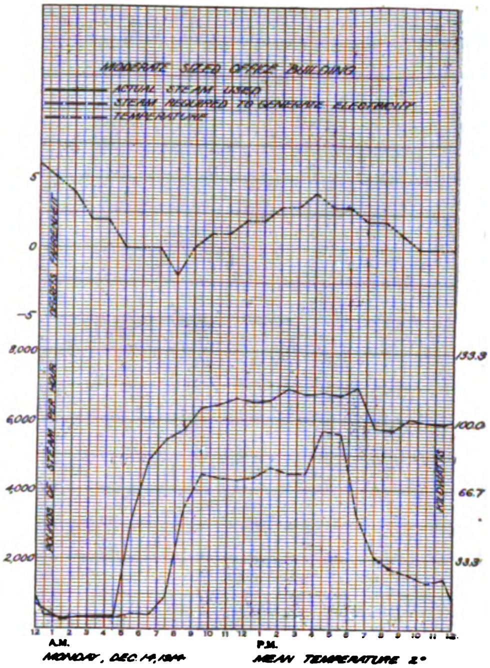


FIG. 6.

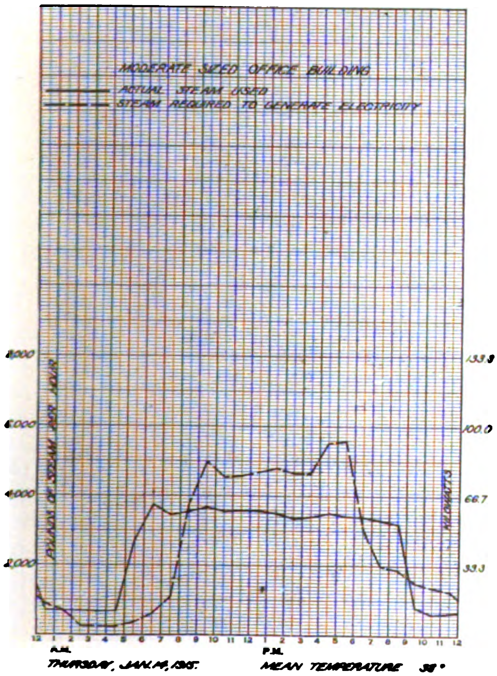


FIG. 7.

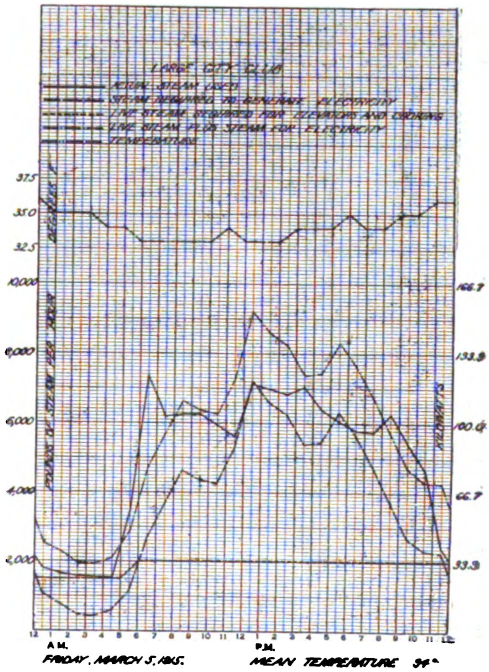


FIG. 8.

LOAD CHARACTERISTICS FOR VARIOUS TYPES OF BUILDINGS.

the electrical requirements. The curve showing the team requirements is used as the basis for figuring the electric curve for the winter load. The space between the steam curve and highest curve will show the amount of exhaust steam which would be necessarily wasted during the summer months if a private plant were in operation.

Fig. 3 shows the conditions of a six-story building in Chicago, which also uses steam for elevator service, but purchases electricity for their lighting and general power. In this figure 3, the electric curve is super-imposed on the summer steam requirements in the same manner as in Fig. 1.

Fig. 4 shows the steam and electric curve during a very cold winter day in a large office building, which is exposed on all sides. This curve shows that in exceptionally cold weather the steam requirements for heating reach very nearly to the steam requirements for electricity throughout the day.

Fig. 5 shows the conditions in the same building on a typical day during moderate winter weather. This curve shows quite a change in the relation between the electric and steam loads and is also on a day which might be considered an average during the winter season. The summer load curve of this building is not given, as there is practically no steam used in the summer time.

Figs. 6 and 7 show the conditions in a moderate sized office building located on the corner and practically exposed on all sides. Fig. 6 shows the conditions in extreme cold weather, while Fig. 7 shows a typical winter day. In this building, also, the steam required in the summer time is practically negligible.

Fig. 8 shows the conditions in a large city club which uses electricity for lighting and power throughout the building, but steam for heating and cooking and ice machinery. This curve represents the conditions on a typical winter day. In order to get the requirements, the electric curve is super-imposed on the summer steam load curve which shows the summer live steam requirements.

These curves have been made up by the method described above, as used by the heat committee of the National Electric Light Association, and most of them are plotted from printometers and compared with the steam load shown by a curve drawing St. John steam-meter. In Fig. 8, however, the steam readings are based on the readings of a Venturi-meter. In Figs. 2, 6 and 7 the electrical curves are based on hourly watt-meter readings throughout the 24 hours.

WHAT THE CURVES REPRESENT.

These curves represent the simultaneous values on typical winter days. In order to get an exact relation between heat and electrical road, it would be necessary to integrate the total electrical and steam requirements for each day and also integrate the simultaneous steam requirements. If this were carried through the entire winter season, it would give us the exact relation for any particular building. While such information requires a considerable amount of labor, it would undoubtedly be interesting information and lend valuable assitance in the problem of analyzing isolated plant conditions.

A general idea of the result can, however, be obtained by taking the average of several typical curves during winter conditions and assuming that as the average condition in the five months during which winter weather can be expected, viz., from November to March, inclusive. It is recognized that a large amount of information and data must be had in order to give a comprehensive view of this somewhat intricate problem. These curves are submitted, therefore, not as conclusive but simply as additional evidence on this subject.

It has been found by experience in Chicago that the annual bills for steam heating in large buildings are from one-fourth to one-third the annual cost of operating and maintaining an independent isolated plant. Accordingly a large percentage of saving in the cost of steam heating would be a relatively small factor in the total cost of maintaining and operating a plant. For example, if 60% of the steam required for heating a building could be utilized in operating dynamos, the saving as compared with the total cost of heat and electricity would be not over 20%.

The curves given herewith are taken from buildings located in the city of

Chicago, and in many of the cities of this country the extreme low temperatures herein shown would not be experienced. It is evident that this is a subject on which it is unsafe to make dogmatic assertions; however, enough has been shown to prove that the central-station man, on the one hand, should recognize that the use of exhaust steam for heating constitutes an important economy in the operation of isolated plants, but, on the other hand, the plan operator should recognize that there are many factors tending to modify the extent of this saving, and therefore it will be well to be conservative in making up estimates of cost based on the theoretical saving to be obtained.

ANALYSIS OF HEATING AND POWER COSTS.

Next in order is to take up the problem of making a thorough analysis of heating and power plant costs in any given building.

The use of central-station service for the small consumer is almost a foregone conclusion. In large buildings and factories the use of isolated plant service was formerly the universal rule. The rapid reduction of central-station rates for electricity for the use of the large consumers and a more thorough appreciation on the part of the public of the many advantages of central-station service have conspired to bring about a great change of sentiment among building owners in the last few years. Some of the largest metropolitan buildings are now buying both electric and heating service from the central-station companies, and in every large enterprise which is projected the question of the advisability of manufacturing the electrical service by a private plant is a much mooted subject.

Every owner wishes to figure out, if possible for himself, the solution of the problem, and in order to make a satisfactory estimate it is necessary to make a very careful and intelligent analysis of the operating conditions of the particular building to be considered. The first step in this analysis is to form an estimate of the annual requirements of the building, for light, power and heat; in other words, to determine the load curves. These estimates should be made by first making a complete plan and schedule of the light and power required, and the probable consumption of electricity in every section of the building. After this estimate is made up very carefully, it should be checked with the consumption of electricity in a number of similar buildings, and if the estimate proves to be radically different from the average result found in other buildings the figures should be carefully looked over, as they probably contain some error.

It has been found in collecting data from various large city buildings that there is quite a strong similarity in the electrical requirements of buildings in the same business and this material forms a very useful guide in making up estimates. In like manner the steam consumption for heating and miscellaneous steam requirements should be carefully estimated and these estimates also checked with the known results in similar buildings. These estimates on steam and electrical requirements form the basis of the comparative estimate as to the cost of operation, whether from central station or from a private plant.

By applying the central-station schedules to the estimated requirements, both for steam and electricity, the cost of steam and electricity is very easily computed. Where steam service is not available the cost of operating an independent steam-heating plant can be figured and then added to the cost of the electrical service, based on the schedules of the local company. To these figures should be added the wages of a few men who would be required to oversee the operation of the elevators and other power and to look after the lighting system. Having arrived at the total cost of the service on the central station basis, it will next be necessary to figure the cost of isolated plant operation, and these figures should be based on the figures of similar plants already installed.

Next month the authors will continue the discussion of operating costs and will give hints on presenting the claims of central station service to prospective patrons.

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THE first formal report of the Chicago Commission on Ventilation, which has just been published, is a document of unusual interest. It covers the entire work that has been carried on by the commission since its inception in 1910, including the tests at the Chicago Normal College, tests in different classes of picture theatres, tests in street and elevated cars and tests with an experimental cabinet. In addition, the report contains the full set of "resolutions," which are the form in which the commission's findings and opinions have been set forth from time to time as the investigation proceeded. These, by the way, are silent on the subject of the recirculation of air.

It is no reflection on the commission's work to say that its results have been largely negative, as far as any basic discoveries are concerned, because such has been the uniform experience of those who have recently been engaged in studying indoor air conditions. The fact is that we seem to have reached an impasse regarding the ultimate definition of "fresh" air, but, far from completing its work, the commission announces that the cabinet tests, for instance, have been only of a preliminary nature, to enable the commission to determine the best method of conducting them, and also to determine the best apparatus required to maintain the desired atmospheric conditions. Also the description of the commission's latest installation in the Chicago Normal College, designed to separate the heating from the ventilating, and providing for the heating of the room through the warming of the floor, is sufficiently novel to bring forth valuable data.

The commission has contributed much to the knowledge of the art by defining in concise terms the present status of applied ventilation, as well as the correct theories, in accordance with present knowledge of the subject. Incidentally, the report illustrates the accomplishments that are possible, even with a limited appropriation, when a determined band of workers get together. In this respect the report constitutes an impressive argument in favor of such work on the part of engineering societies.

WE TAKE pleasure in announcing an important new book, entitled "District Heating," by S. Morgan Bushnell and Fred B. Orr. This work comprises the articles on the same subject that have appeared recently in our columns and contains, in addition, an unusual quantity of operating and other data, drawn from the authors' extensive experience in central station heating work. "District Heating" is easily the most exhaustive treatise on this subject that has made its appearance and is a volume worthy of the commanding position which the district heating industry is assuming in many sections.

NATIONAL DISTRICT HEATING ASSOCIATION

Programme for Seventh Annual Convention

Following is the detailed programme of the seventh annual convention of the National District Heating Association, which will be held at the Hotel Sherman, Chicago, Ill., June 1, 2 and 3, 1915. The sessions will be held in the Grey Room and the exhibit, which is always an important feature of the convention, will be in the Louis VI Room:

FIRST SESSION, TUESDAY, JUNE 1, 10:30 A. M.

Welcome Address.
Response.
President's Address.
Report of Secretary-Treasurer.
Report of Executive Committee.
Election of Members.
Appointment of Nominating Committee.
Report of Station Record Committee—A. P. Biggs, Edison Illuminating Co., Detroit, Mich., Chairman.

SECOND SESSION, TUESDAY, JUNE 1, 2:30 P. M.

Paper—"Commercial End of the Heating Business," C. F. Oehlman, Denver Gas & Electric Co., Denver, Colo.
Address—Walter A. Shaw, member Public Utilities Commission of Illinois.
Report of Nominating Committee.

THIRD SESSION, WEDNESDAY, JUNE 2, 9:30 A. M.

Report of Committee on Underground Construction, H. A. Woodworth, Merchants Heat & Light Co., Indianapolis, Ind., Chairman.
Paper—"Operating Experience with Bleeder Type Turbines," F. W. Lass, Chief Eng. Iowa Ry. & Light Co., Cedar Rapids, Iowa.
Paper—E. F. Tweedy, New York Edison Co., New York City.
Election of Officers.

FOURTH SESSION, WEDNESDAY, JUNE 2, 2:30 P. M.

Report of Public Policy Committee—D. L. Gaskill, Greenville, O., Chairman.
Address—J. F. Gilchrist, Vice-President Commonwealth Edison Co., Chicago.
Report of Educational Committee—D. S. Boyden, Edison Illuminating Co., Boston, Mass., Chairman.

FIFTH SESSION, THURSDAY, JUNE 3, 9:30 A. M.

Paper—"The Hot Water Heating System at the Grand Central Terminal," W. G. Carlton, engineer, New York City.
Report of Station Operating Committee—B. T. Gifford, American Public Utilities Co., Grand Rapids, Mich., Chairman.

SIXTH SESSION, THURSDAY, JUNE 3, 2:30 P. M.

Paper—"A Pressure Study of a Steam Distribution System," C. C. Wilcox, Eng. Hodenpyl Hardy Co., Jackson, Mich.
Paper—"Exhaust Steam vs. Live Steam for Heating," Geo. W. Martin, New York Service Co., New York City.

CONVENTION COMMITTEES.

Finance, H. C. Kimbrough, F. F. Vater and Albert K. Root.
Entertainment—Harold Almert, Fred B. Orr, L. S. Shaw, Oliver H. Hogue, George H. Jones, John G. Learned, J. L. Hecht, M. S. Hart, Leslie B. Fiske.
Local Plant Visiting—J. T. Kelly, S. S. Gregory, Frank A. Vath, H. C. Heaton, C. W. Pen Del.

ENTERTAINMENT.

Following are the principal entertainment features:
Tuesday afternoon: Ladies' musical and card party at Hotel Sherman.
Tuesday evening: Theater party for all.
Wednesday morning: Shopping excursions for the ladies.
Wednesday afternoon: Automobile ride to South Shore Country Club, through Washington and Jackson Parks, with tea at the South Shore Country Club at 4:30 to 5 o'clock.
Wednesday evening: Banquet. Entertainment, dancing.
Thursday morning: Shopping tours for the ladies.
Thursday afternoon: Automobile ride along Lake Shore Drive to Mission Tea Room.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

44—Cooling Coils for Lowering Temperature of Condensation.

QUESTION: How large a cooling coil will be necessary for 5,000 sq. ft. of radiation operating under 5 lbs. steam initial, or 227° F.?

ANSWER: Cooling coils are more or less guessed at and as long as there is one between the trap and the sewer, it is often passed as O. K. by the authorities. Under higher pressures of steam, when the trap discharges, there is always a percentage of water re-evaporated into steam, due to the high temperature of the condensation and the reduction of the pressure to atmosphere so that the water will become 212° F.

The cooling coil should be between the trap discharge and the sewer and it is policy to seal the outlets so that the coil will always be full of water unless it is desirous to drain it to prevent freezing when it is in a space below 32° F.

If we assume 3 lbs. water per square foot of radiation, there will be 15,000 lbs. per hour. The water may possibly be at a temperature of 220° F. and a certain amount will vaporize into steam until the water becomes 212° F.—and atmosphere pressure.

We will assume the surrounding air 50° F. in extreme weather or whatever it may be in any individual case. The higher the temperature, the more radiation required. The transmission will be assumed 1.8 B. T. U. per square foot, per hour, per degree difference in temperature between surrounding air and water. The condensation should be reduced to 180° F. at least, but the coil is seldom of sufficient size especially if the job is large. The average temperature of the heating surface will be about

$(180+220) \div 2 = 400 \div 2 = 200°$ F.

so the B. T. U. per square foot will be about

$1.8 \times (200 - 60) = 252$ B. T. U. per hour.

The heat of the radiation is

$220 - 180 = 40 \times 15{,}000 = 600{,}000$ B. T. U. per hour.

$600{,}000 \div 252 = 2{,}400$ sq. ft. surface required.

It is readily seen that there is a lot of heat in this water and especially if the water is cooled to any extent, a job like the above would be more likely to have a coil of about 10% of this in practice. If the water goes to the sewer at 212° F. all right; if not, it is figured that a little steam will not be noticed. If the pressure is released, the evaporation of the condensation will quickly bring the temperature to atmosphere. Any other conditions may be assumed and the size of coil figured in the manner indicated.

It is always policy to utilize this heat in some manner and the use of very low pressures in heating would entail greater economy if provision cannot be made to utilize the heat from the cooling coil to advantage.

45—Significance of Different Pressure Terms.

QUESTION: Will you kindly inform me as to the meaning of the expressions: (a) Static pressure; (b) dynamic pressure; (c) total pressure; (d) resistance? Also how the static, dynamic and total pressures are measured, how resistance is measured, and what is meant when it is stated that a fan discharges a certain volume of air against a certain pressure? Is static, dynamic or total pressure intended?

ANSWER: Static pressure refers to the pressure when there is no movement of the fluid. It may refer to the total head available for all purposes. Dynamic pressure refers probably to the quantity known as velocity head or the portion of the pressure changed into velocity. Total pressure means the sum of all the pressures and will always be equal to the head when there is no movement. The total pressure may be static. Resistance is the total head minus the velocity head; also the total head minus the velocity head is the resistance.

A fan discharges a certain amount of air against a certain pressure which equals the velocity head plus the resistance. The total pressure is maximum when there is only a slight opening and small discharge and the resistance is maximum. As the discharge is opened, the volume increases with the velocity head and the resistance goes down. The relation between the pressure at the fan discharge, the area of opening and volume is

found in the characteristic curve for each machine. When the opening is entirely closed, the pressure depends on velocity of blades, speed, etc., and as a rule, the fan takes practically no power, but will show a pressure. As the opening is increased, the air flows, the fan takes power and the pressure on the discharge is reduced, part being used for velocity head and part for friction head or the resistance to flow at the velocity due to area and length of pipe.

This is an incomplete explanation, but will readily be understood if the characteristic curves of any fan are obtained from the manufacturer giving relation between speed, pressure, volume, etc.

The curves are analogous and follow somewhat the same laws as the characteristic curves for dynamos when plotted between volts, amperes, watts, and speed, and centrifugal pumps handling water when the curves are plotted between head, volume, horsepower, etc.

LEGAL DECISIONS

Breach of Contract for Installing Steam-Heating Apparatus—Damages Recoverable.

The R. C. Bartley Company contracted with one Lee to put a heating apparatus in his house, reserving title until he had paid for it. He paid a portion of the purchase price, but refused to pay the balance, and when suit was brought claimed damages. The trial judge decided the facts in favor of the plaintiff, and awarded judgment for the balance of the purchase price. The defendant appealed. The only question presented by the appeal was whether it was proper to allow the Bartley Company to recover the balance of the purchase price or whether they should have been restricted to a recovery of the damages for breach of an executory contract of sale. The defendant's theory was that as the title did not pass, although the heating apparatus was in his house, the only remedy of the plaintiff was for breach of an executory contract. Whether this was to be regarded as a working contract or a contract of sale strictly so called was held to be of no importance. Assuming in the defendant's favor, that it was a contract of sale, the law is settled adversely to his contention. No satisfactory solution of the rights of the parties in such a transaction can be found without observing that the essential character of the transaction is the same as that of an absolute sale with a mortgage back. The plaintiff, therefore, could maintain an action for the purchase price. Judgment for the plaintiff was affirmed.—R. C. Bartley Co. vs. Lee, New Jersey Supreme Court, 93 Atl., 78.

Contract for Installing Heating Plant—Claim for Extras.

Action was brought on a contract for installing a steam-heating plant in a church. The plaintiff claimed that the contract did not require him to cover certain pipes in the basement with asbestos felt, but that he did cover them in pursuance of an order of and an agreement with the architect, and he claimed compensation therefor as an extra. There was no express language in the contract which obliged the plaintiff to cover the pipes, but the defendant argued that if the contract did not in express words require the plaintiff to cover the pipes, his guaranty that the system installed should have the capacity to heat the church to 70° F. when the outside temperature was 10° below zero, would require them to be covered. It was insisted by the defendant that unless the pipes were covered this guaranty could not be complied with. The contention of the plaintiff was directly opposed to this. This, it was held, raised a disputed question of fact, which was properly submitted to the jury, who found for the plaintiff.

It was urged by the defendant that if the covering of the pipes were an extra, the plaintiff could not recover because of section 5 of the general specifications, which provided that no claim for extra work should be considered unless the price for the same should have been agreed upon in writing between the owner, contractor and architects, prior to the commencement of the same. It was conceded by the plaintiff that this provision was not complied with, but it was shown that the architect ordered the work to be done, and arranged with him orally to do it. It was further contended by the defendant that the architect's decision as to whether the contract included the covering of the pipes was final under the eighth section of the general specifications which provided that, in case of dispute as to the meaning of the drawings or specifications, the architects' decision thereon should be final and binding on all parties. The plaintiff answered that these provisions were included in the general specifications, which were never delivered to him, and of which he had no knowledge; that his bid was made and the contract was based upon the "special heating specifications" only. This question was held properly submitted to the jury with

the instruction that if they found that the general specifications were delivered to the plaintiff prior to the making of the contract the plaintiff could not recover. It was also held that testimony that other extras arranged for orally by the contractor was properly admitted for the purpose of showing a waiver of that portion of the contract which provided that all claims for extras should be made in writing within ten days from the beginning of the work. Judgment for the plaintiff was affirmed.—Wenzel vs. Kieruj, Michigan Supreme Court, 151 N. W., 641.

CORRESPONDENCE

Test of Economy and Efficiency of Automatic Temperature Regulation.

EDITOR HEATING AND VENTILATING MAGAZINE:

The article on reporting the test of economy and efficiency of automatic temperature regulation in office buildings by F. A. Boos, which appeared in your April issue, contains some statements which are not entirely clear to me.

It states that the radiator tested was supplied with steam by an overhead distribution single pipe air line vacuum steam system. Further in the article it states that the graduated type of thermostat was used during a portion of the test. The writer fails to understand how it was possible to throttle the steam supply to a radiator connected with such a system without causing water logging of the radiator and thereby its failure to heat properly. Evidently the system installed in the building is not the same as described, otherwise, the writer is at a loss to understand how the results described could be obtained.

The writer cannot understand what line of deduction makes possible the statement that 25 per cent. less radiation can be used with automatic temperature than in the case where no temperature control is provided. The room in which the test was made apparently has cubic contents of 1,920 cu. ft. exposed net wall of 77 sq. ft. and exposed glass area of 50 sq. ft. This room will require 26 sq. ft. of radiation by Prof. Woodbridge's rule, 32 sq. ft. of radiation by Mills' rule and 22½ sq. ft. of radiation by Baldwin's rule, to heat same to 70° F. when the outside temperature is 11° F. The radiator provided contains 45 sq. ft., which accounts for the fact that the radiator was in use but about 8 per cent. of the time. As the minimum temperature in Kansas City, as stated by the United States Weather Bureau, is 20° below zero, it can be readily understood why the additional radiation was installed, and there is no doubt that a considerable saving of fuel is possible by the temperature regulation. However, should the outside temperature be 20° below zero the radiator would then be turned on all the time, even were temperature control provided. And as the building must be heated to 70° under all conditions of outside temperature liable to occur, the same amount of radiation would be necessary with or without temperature control.

The article headed "Operating Cost of Electric Heating Devices" which also appears in this issue, states that 100 per cent. efficiency is possible with electric heating. The writer must taken exception to this in that there must be some loss in the wire which supplies current to the radiator. The heat generated in this wire will not be available in the apartment where the radiator is located and the writer would consider that 90 to 95 per cent. efficiency would be the maximum possible with electric heating.

In figuring the relative cost of coal and electric current for heating purposes, it is stated that electricity at 56 cents per kilowatt hour is the fuel equivalent to coal in the State of Washington. This is evidently a typographical error, as a calculation on the basis stated in the article shows that the cost of electricity should be 56/100 cent per kilowatt hour as the fuel equivalent for coal.

M. S. COOLEY.

Washington, D. C.

REPLY BY F. A. DE BOOS.

Your correspondent is entirely correct in his assumption that the overhead distribution single pipe air line vacuum system would cause water logging of the radiator when the intermediate thermostat is used. However, we only used the intermediate instrument for one day and while there was considerable hammering and pounding of the radiator in consequence of the intermediate control we were not particularly concerned with the temporary inconvenience. Of course, intermediate thermostats should not be used on an air line vacuum steam system, but as we desired to show the difference in the control of the two types of instruments we substituted the intermediate thermostat temporarily as explained above.

The statement that 25% less radia-

tion would, perhaps, be needed with automatic temperature control was based on the assumption that in planning the average heating plant the theoretical amount of radiation is determined from one of the various standard rules, and the general practice is then to add to this amount. With a reliable system of temperature control, accurately gauging the heat for each room of the entire building, such practice would not be necessary. The winter temperature in Kansas City very rarely goes much below zero, and in general heating plans are figured on a basis of zero to ten below.

Of course, when the entire capacity of the heating plant is required to meet the outside weather conditions, temperature control would effect the minimum saving. But it is this fact that the heating plant must be designed for the severer weather conditions that affords the temperature regulation opportunity to make such a large fuel saving, as, in general, the heating plant will be operated at only a small fraction of its capacity. With hand control the room soon overheats and windows are generally opened and the radiator left going. The saving in this particular instance is shown clearly by the chart of February 12, where the temperature was raised from an average of approximately 18½° F. to 71° F. and kept at approximately 71° by the operation of the thermostat, and yet the radiator was in use only about 8% of the time.

Relation of the Architect to the Engineer.

EDITOR HEATING AND VENTILATING MAGAZINE:

Referring to the article on "The Relation of the Architect and the Engineer," in your March issue, I would say that I am intensely interested in this subject which was very well treated by Mr. Kimball.

There is in vogue in some cities in the States a plan whereby a number of architects submit all their work to one office of mechanical engineers and a set scale is made in regard to rates. Could you inform me of the details of this plan, and also some general data regarding the rates charged by engineers and whether the architect or owner pays?

E. H. JOHNSON.

Camrose, Alberta.

REPLY BY D. D. KIMBALL.

I have never heard of any such arrangement as that referred to by your correspondent. Certainly no such system exists in this city, nor in Boston, Philadelphia, Washington, Buffalo, Pittsburgh, Chicago, Cleveland, Cincinnati or St. Louis, nor so far as I know elsewhere. Among the best engineers I believe the practice prevails of establishing a rate of 6% in localities where architects are customarily paid 6%, and 5% where the architects are customarily paid 5%, but a special concession is usually made to the architect where he is obliged to assume the entire cost of engineering services, this concession usually being equal to a 30% reduction in rate. Where the owner reimburses the architect for the cost of engineering services, of half or more thereof, the full rate is customarily charged by the engineer.

Variation of Temperature at Different Room Levels in Furnace Testing.

Editor HEATING AND VENTILATING MAGAZINE.

What variation in temperature for each foot in height, from floor line to ceiling, is allowed when testing out a furnace heating apparatus? The writer has been informed that, taking 5 ft. 6 in. above the floor line as the breathing line, an allowance of 1° per foot difference in temperature, below or above the breathing line is considered a reasonable variation in the temperature of the room being tested, it being understood that there should not be a difference of more than 2° at the same level in the room.

H. D. F.

Greenwood, S. C., March, 1915.

REPLY BY ROY L. LYND.

I do not know that I have ever heard of engineers in this country going into very great refinements on the question of temperature difference between the floor and ceiling of a room. The German engineers, however, do consider this point in their designs, and I quote from "Formulas and Tables for Heating," by J. H. Kinealy, as to their methods of treating the problem:

"H must be calculated for each wall and each cooling surface, floor or ceiling, of a room, and the sum of these quantities is the total heat loss per hour for that room. The different values of t_o to be used are given in Table II. For the walls, windows and other vertical surfaces of a room whose height from floor to ceiling is not over 10 or 12 ft. the value of t_i used may be taken from Table I. But where the height of the room is greater than 10 or 12 ft. the temperature of the warm air is greater near the ceiling than near the floor, and the mean temperature of the air must be taken as t_i. Reitschel calculates the temperature, t', of the air at the ceiling of a room by the formula

$$t' = t + 0.03(h - 10)t,$$

where t is the temperature at a distance of 4½ or 5 ft., "head high," from the floor.

"The temperature at the floor is assumed to be t, and the mean temperature, t_1, is given by the equation

$$t_1 = \frac{t'+t}{2} = t + 0.015(h - 10)t$$

Reitschel says, however, that t' should not be assumed as greater than about 1.3 t, and therefore it follows that t_1 should not be assumed as greater than 1.15 t.

"When determining the loss of heat from a warm room through a ceiling, Reitschel takes t_1 as equal to t', which he calculates by the equation given above; and when determining the loss of heat from a warm room through a floor Reitschel takes t_1 as equal to t, the temperature 'head high' above the floor.

"Neither Klinger nor Recknagel follows the method adopted by Reitschel of determining the mean temperature of the air in contact with the cooling wall and using it in calculating the heat loss; but they use the temperature that is to be maintained in the room, measured about 5 ft. above the floor, when calculating the heat losses, and increase these losses by an amount which depends upon the height of the room as shown by the following paragraph.

ADDITIONS TO THE CALCULATED HEAT LOSSES.

"The German engineers usually make certain additions to the heat losses determined by the method shown above, which depend upon unusual exposure or upon interruption in the heating.

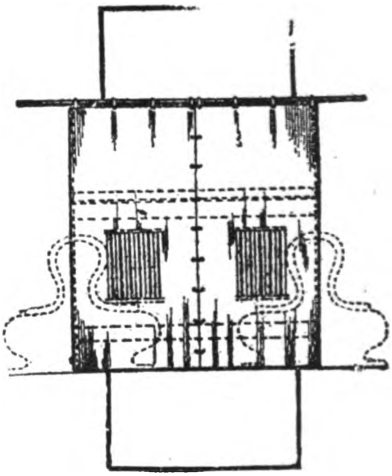
"The increases recommended by Recknagel are: 25% for surfaces having a northern, northeastern or northwestern exposure; 20 to 30% for surfaces exposed to winds; 10% of the total heat losses for rooms more than 13 ft. from floor to ceiling; 20% of the total heat losses for rooms in which the heating is interrupted daily.

"The increases recommended by Klinger are, in general: 20% for corner rooms and 10% for other rooms. For more exact work: 10% for surfaces having a northern, eastern, western, northeastern or northwestern exposure; 5% for corner rooms; 3% for rooms from 12 to 14½ ft. from floor to ceiling; 6½% for rooms from 14½ to 18 ft. from floor to ceiling; 10% for rooms more than 18 ft. from floor to ceiling; 10% when the heating is continued during the day only and the building is closed up during the night; 30% when the heating is continued during the day only and the building is open during the night; 50% when the building remains for long periods without heat.

"Reitschel recommends the following increases on account of exposure: 10% for surfaces having a northern, eastern, northeastern or northwestern exposure; and 10% additional for surfaces that are especially exposed to the wind."

Scheme for Ventilating Sleeping Car Berths.

A Canadian has invented a method for ventilating sleeping car berths through the use of louvred openings in the curtain enclosing the berth. Each curtain is supplied with an opening, making two openings for each section. These openings are covered with a series of vertical louvres, those of one curtain being arranged to face opposite to those of the other curtain in order that the air may be deflected into the berth irrespective of the direction of travel of the coach.



CURTAIN FOR SLEEPING CAR BERTH ARRANGED WITH VENTILATING LOUVRES.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

DUST REMOVAL—

State Laws on Removal of Dust. H. Cole Estep. Analysis of the legislation in every state. Ills. 7,000 w. Ir Trd Rev—Feb. 25, 1915. 20c.

RADIATION—

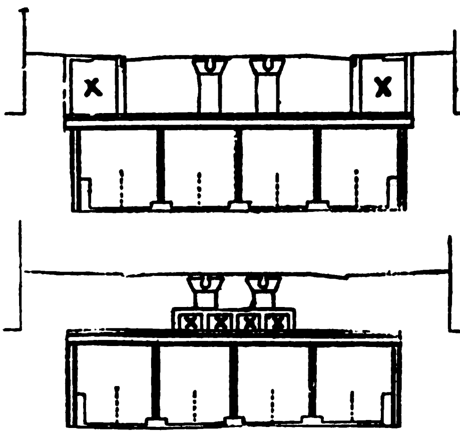
Modified System for Estimating Radiation. Carleton F. Tweed. Gives practical working rules with tables for using the common heat unit method. 4,500 w. Prac Engr, Chicago—Feb. 15, 1915. 20c.

Proposed Rules in New York State for Removal of Dust, Fumes and Gases.

Rules relating to the removal of dust, gases and fumes, proposed by the Industrial Board of the New York State Department of Labor, were the subject of public hearings held at Syracuse, April 27, and at the office of the Industrial Board, in New York, April 29. The proposed rules are based on Sections 81, 82 and 86 of the law on this subject. Regarding grinding, polishing or buffing wheels used in the course of manufacture of articles of the baser materials, the rules cover such items as hoods, size of branch pipes, size of main pipes and fan inlets and outlets, suction, arrangement and construction of pipes, clean-out doors, dampers and fire doors, ventilation, belts and plans. Other rules apply to machines creating dust or fumes; and fumes, vapor or gases. A separate rule is drawn to cover lead dust and fumes. Copies of the proposed rules may be had by addressing the secretary of the board, John Williams, 381 Fourth Avenue, New York.

A Method for Overcoming the Use of Sidewalk Gratings in Subway Ventilation.

The agitation over the use of sidewalk gratings as air outlets in the ventilation of the extensions to the New York subway has led to the proposal shown in the accompanying sketch for obviating the use of such gratings. In the upper sketch is shown the system of ventilation now



PRESENT AND PROPOSED METHODS OF VENTILATING NEW YORK'S NEW SUBWAYS.

planned for the new subways on Broadway and elsewhere. The spaces in the upper left and right hand corners (marked X) represent outlets under the sidewalks with gratings, some of which have been already installed. It is contended that the outrushing air through these sidewalk gratings would be particularly unsanitary and objectionable on Broadway, where the sidewalks in front of the large stores and hotels are usually crowded.

The lower sketch shows the ventilation system designed by George Hallet Clark, engineer. With this arrangement, air would be exhausted from the subway through the small ducts (marked X) shown directly above the tunnel and forced out at such open spaces as Union Square, Madison Square, Herald Square, etc. This system of ventilation, it is claimed, would be continuous, while the other plan would be fitful.

An item on another page of this issue notes the action of the Public Service Commission in voting to call in a firm of ventilating experts on the matter.

Separate Contract Law Passed in New Jersey.

The separate contract bill, which was introduced in the New Jersey legislature last January, became a law March 29, 1915, when, after a hearing in the executive chamber, it was signed by Governor Fielder.

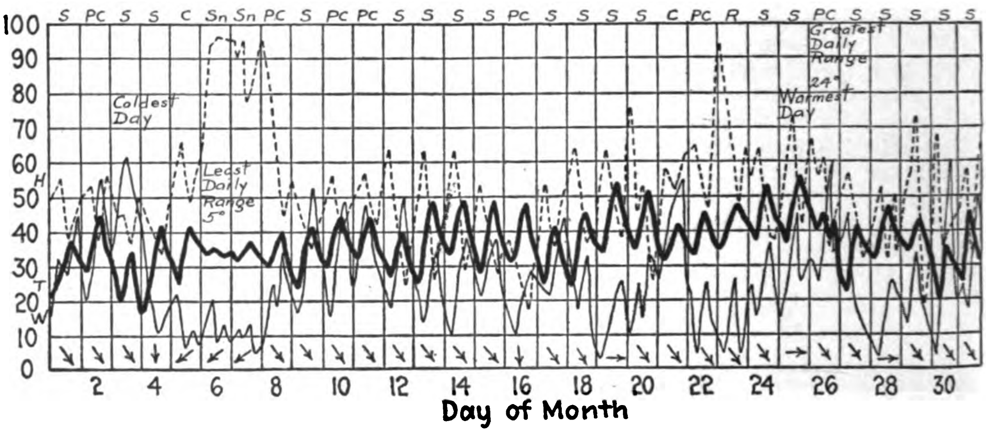
The new law is listed as Chapter 95 of the Laws of 1915 of the State of New Jersey and is as follows:

1. Hereafter in the preparation of plans and specifications for the erection, construction, alteration or repair of any public buildings in this State, whether the same is to be erected, altered or repaired by the State or any political subdivision thereof, when the entire cost of such work will exceed one thousand dollars in amount, it shall be the duty of the architect, engineer or other person preparing such plans and specifications to prepare separate plans and specifications for the plumbing and gas fitting, and all work kindred thereto, and of the steam and hot-water heating and ventilating apparatus, steam power plants and work kindred thereto, and electrical work; and it shall be the further duty of the board or body, person or persons authorized by law to award contracts for the erection, construction, alteration or repair of any such public building, to advertise for, in the manner provided by law, and to receive separate bids for each of said branches of work, and to award contracts for the same to the lowest responsible bidder for each of such branches respectively.

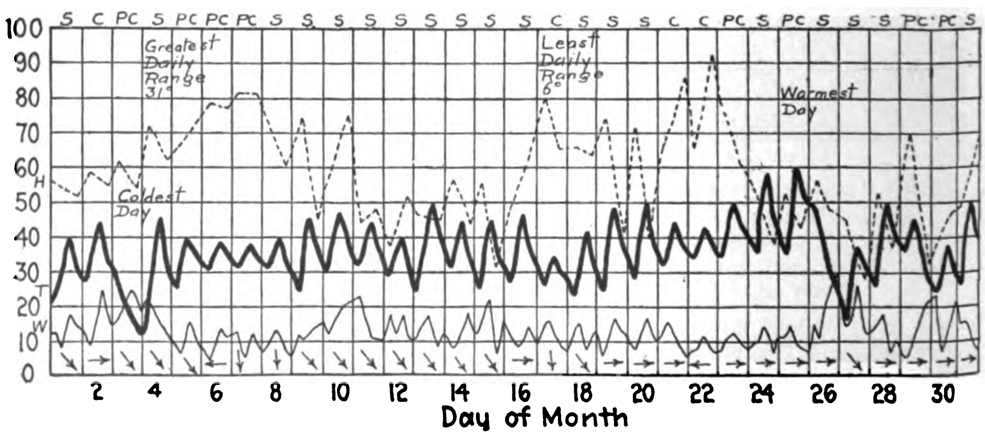
2. All acts or parts of acts inconsistent herewith are hereby repealed, and this act shall take effect immediately.

The Weather for March, 1915.

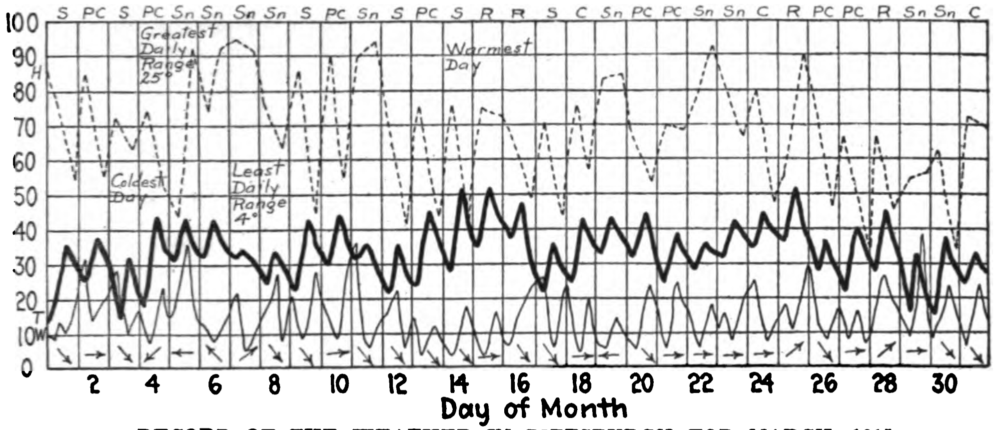
	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F.	55	60	51	57	61
Date of highest temperature	25	25	14	24	24
Lowest temperature, degrees F.	18	13	15	21	28
Date of lowest temperature	3	3	3	29	29
Greatest daily range, degrees F.	24	31	25	22	27
Date of greatest daily range	26	4	4	24	24
Least daily range, degrees F.	5	6	4	4	4
Date of least daily range	6	17	7	6	6
Mean temp. for month, degrees F.	36	36	33	35	38.5
Normal mean temp. for month, deg. F.	37.5	35	39.5	34.4	43.5
Total rainfall, inches	1.14	..	1.26	0.6	0.44
Total snowfall, inches	7.7	..	5.8	3.6	2.00
Normal precipitation, this month, in.	4.1	4.08	3.01	2.55	3.43
Total wind movement, miles	16661	9237	9347	7909	8184
Average hourly wind velocity, miles	22.4	12.4	12.6	10.6	11
Prevailing direction of wind	N.W.	N.W.	N.W.	N.W.	N.W.
Number of clear days	19	20	8	11	6
Number of partly cloudy days	7	8	11	8	12
Number of cloudy days	5	3	12	12	13
Number of days on which rain fell	4	..	12	7	10
Number of days on which snow fell	2	..	10	4	3
Snow on ground at end of month	..	..	Trace	..	..



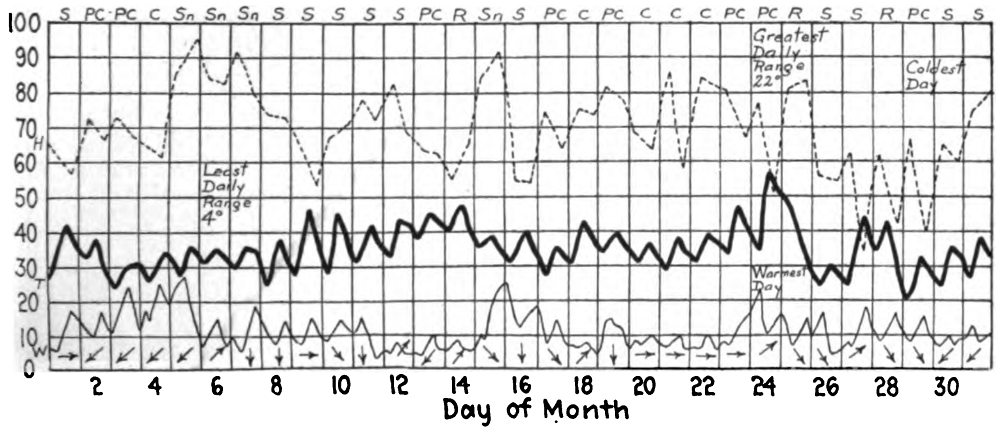
RECORD OF THE WEATHER IN NEW YORK FOR MARCH, 1915.
(Relative Humidity Curve is Plotted from Hourly Observations.)



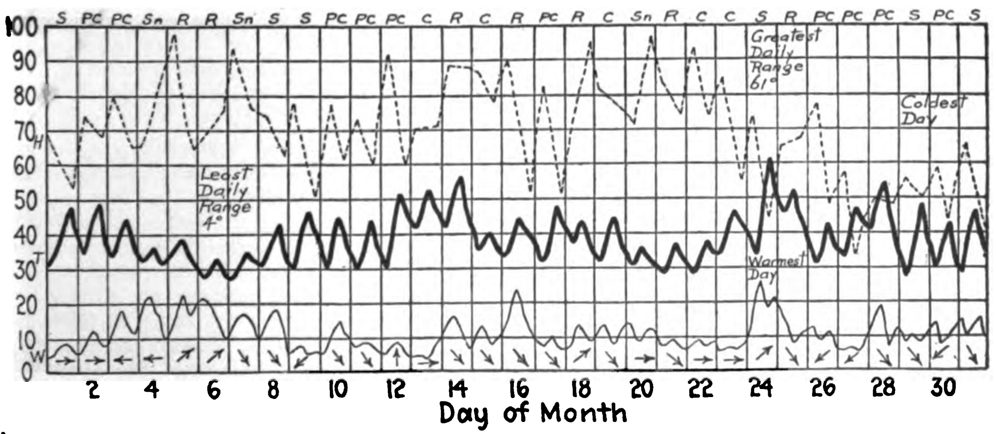
RECORD OF THE WEATHER IN BOSTON FOR MARCH, 1915.



RECORD OF THE WEATHER IN PITTSBURGH FOR MARCH, 1915.



RECORD OF THE WEATHER IN CHICAGO FOR MARCH, 1915.



RECORD OF THE WEATHER IN ST. LOUIS FOR MARCH, 1915.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

United States Government to Publish Mid-Day Humidity Readings.

The United States Weather Bureau, in the past, has only published the temperature and humidity readings morning and evening and the temperature only during noon time, and it has been customary for the daily papers to publish the maximum and minimum temperature and the average relative humidity. This has served, in many cases, to create a wrong impression in the mind of the public regarding the humidity. For instance, with maximum and minimum temperatures of, say, 95° F. and 70° F. a relative humidity of, say, 90%, it would appear that the relative humidity at 95° was 90%, whereas, as a matter of fact, the 90% relative humidity was only during the morning and evening, or, in other words, during the periods of minimum temperature.

Due to the initiative of W. G. R. Braemer, manager of the air conditioning department of Warren Webster & Co., Camden, N. J., announcement is made by Professor C. H. Marvin, chief of the United States Weather Bureau, that "action will be taken looking to the publication of these data (mid-day humidity readings) at the weather bureau stations where found practicable."

In a letter to Professor Marvin, which resulted in the action stated, Mr. Braemer said that the erroneous impressions obtained by the public from the weather bureau reports is a source of much annoyance to all interested in the manufacture of air conditioning apparatus, inasmuch as inquiries are often received from clients to furnish estimates on apparatus to cool air, say, from 95° F. and 90% relative humidity, to 70° F., and, of course, considerable correspondence is involved and many times the prospective client will give up the matter because of the tremendous cost of the apparatus to take care of the condition he specified, which never exists in actual practice.

A New Industrial Commission Bill for New York State.

A bill to create an industrial commission, which will administer all labor laws, including the inspection of workplaces, has been introduced in the New York State legislature. The bill has been reported favorably by the Senate committee on labor and industry. If it is passed, the head of the labor department will be succeeded by an industrial commission consisting of five members appointed by the governor for terms of six years each at salaries of $8,000 each. To advise the industrial commission, an industrial council, equally representative of employers and employees, is provided for. In addition to abolishing the office of commissioner of labor, the bill would do away with the workmen's compensation commission and the industrial board in the Labor Department, which at present has the power, among other things, to make rulings regarding the heating and ventilation of factory buildings. The purpose of the change is to secure greater economy and efficiency through the unified administration of all labor laws. The proposed law has the endorsement of the American Association for Labor Legislation.

American Society of Heating and Ventilating Engineers

New York Chapter Elects New Officers.

William H. Driscoll was elected president of the New York Chapter at its April meeting, when reports of the officers for the year were also presented. Arthur Ritter was elected vice-president; W. J. Olvany, treasurer; F. K. Davis, secretary, and W. S. Timmis, W. F. Goodnow and Perry West, governors.

The treasurer's report showed a cash balance of $381.45. The receipts for the year were $329.80 and the expenses $202.45. The secretary reported a membership of 75, as compared with 71 at the beginning of the year.

The report of the chapter dinner committee, recommending a $5.00 dinner, was finally adopted after discussion. It will be held May 17 at the Claridge Hotel, Broadway and 44th Street, New York.

On motion of W. M. Mackay, the name of William J. Baldwin was presented for honorary membership in the chapter, and it was voted to recommend such action to the board of governors. It was also voted, on Mr. Mackay's motion, to recommend to the society that a portrait be obtained of its first president, E. P. Bates, of Syracuse, to be hung at the society headquarters, alongside of the portraits of the other past presidents.

The talk on "export engineering," which was to have been given by Rawson Vaile, manager of the export department of the American Blower Company, was put to a later date, owing to the unavoidable absence of Mr. Vaile.

President Timmis reported for the build-

ing code committee, stating that the committee, composed of Messrs. Chapman, Ohmes and Kimball, had met Rudolph P. Miller, of the building code commission, and had presented their recommendations regarding the proposed heating and ventilating ordinances. President Timmis, in resigning the chair, expressed his thanks to the members for their courtesy and co-operation and bespoke the same co-operation for his successor.

Illinois Chapter.

Methods of heating and controlling the temperature of swimming pools and shower baths were presented at the April meeting of the Illinois Chapter by Leo H. Pleins, sanitary engineer for James B. Clow & Sons, of Chicago. Mr. Pleins advocated the closed type heater in preference to the injector method of heating swimming pools.

An appropriation of $50 made to the committee on pipe covering was reappropriated to the committee on air washing. In this connection Dr. Vernon Hill, of the Division of Ventilation of the Chicago Health Department, described the equipment for testing air washers which has been installed in the pent house on the roof of the Chicago City Hall. This experimental plant, he announced, is open to any who desire to visit it. Among those present at the meeting was W. G. Braemer, of Warren Webster & Co., Camden, N. J., who invited the members to visit the company's air conditioning plant and laboratory in Camden.

The May meeting, scheduled for May 10, was in charge of the committee on air washing and marked the close of the season.

Massachusetts Chapter.

Laurence Franklin was the principal speaker at the April meeting of the Massachusetts Chapter which was held at the New City Club, April 13, with Past-President W. G. Snow in the chair. Mr. Franklin showed and explained in detail a number of heating and ventilating plans, made in 1883 by his father, the late Albert B. Franklin, for some of the Boston school buildings. These plans were among the first made by Mr. Franklin and aroused much interest. The speaker was given a vote of thanks at the close of his remarks.

Frank Irving Cooper presented a synopsis of the proposed law now before the Massachusetts legislature, relating to the construction, alteration and maintenance of buildings. This is House Bill No. 1750, and has been reported favorably by the committee to which it was referred. It was voted to invite Frank T. Chapman, of the committee on minimum heating and ventilating standards of the society, to appear before the legislature on behalf of the society to further the passage of the bill. It was also arranged to have Vice-President Eugene R. Stone, Secretary Charles Morrison and Mr. Cooper attend this hearing.

An amendment to the chapter's by-laws was passed changing the date of the annual meeting from October to May, so as to give the newly-elected officers an opportunity to develop their plans for the ensuing year. It was stated that several of the chapter members were arranging to attend the society's summer meeting in San Francisco in September.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Michigan State Association.

The Michigan State Association of Master Steam and Hot Water Fitters elected the following officers at its second annual convention, held in Detroit, April 8: President, William Gourlay, Jr., Detroit; vice-president, William Pulte, Grand Rapids; secretary-treasurer, Otto Wurm, Detroit. Members of executive committee: Charles A. Blaney, Kalamazoo, and C. L. Bigelow, Saginaw. After the meeting was called to order by President Julius A. Ziesse, an address was made by William F. McDonald, of Detroit, who spoke on live problems in the heating trade, such as low bidding, relations of the architect to the engineer and loosely drawn specifications. C. P. Tietze, of Detroit, who also spoke, advocated better janitor service to secure proper operation of heating installations. During the midday recess, an inspection was made of the new building for the Detroit Athletic Club, the heating system for which was installed by the Vinton Plumbing & Heating Co. The trip was in charge of James R. Bolton, president of the Detroit Master Plumbers' Association.

New York City Association.

Following are the new officers of the New York City Association of Master Steam and Hot Water Fitters, elected at its annual meeting, March 23: President, Joseph G. Geoghegan; vice-president, William H. Curtin; treasurer, J. E. Rutzler; secretary, H. B. Gombers. Board of Directors: Joseph G. Geoghegan, William H. Curtin, J. E. Rutzler, Michael J. Callahan and G. F. Steffany.

Detroit (Mich.) Association.

James W. Partlan, the retiring president of the Detroit Association of Master Steam and Hot Water Fitters, was presented with a silver cup as a token of appreciation on the part of his fellow members. The presentation took place March 10 when 25 members surprised him at his home.

Pennsylvania State Association.

The annual convention of the Pennsylvania State Association of Master Steam and Hot Water Fitters is scheduled for Philadelphia, Pa., May 27.

Class Dinner of New York Heating and Ventilating School.

Fifty members and guests of the New York Heating and Ventilating School attended the annual dinner of the class which was held at the Wool Club, New York, April 12. Charles A. Fuller, director of the class, presided, and the office of toastmaster was filled by Frank K. Chew. It was stated that during the past season the school had an enrollment of 39 members. The speakers included Frank T. Chapman, R. L. Pryor, W. J. Olvany, Max M. Peabody, "Jack" Armour, famous for his wit and humor, and Mr. Kraft, of the Westinghouse Electric & Mfg. Co. The dinner arrangements were made by George G. Schmidt, secretary of the school.

New Kingsbury Hot Blast Heater Soon to Be Placed on Market.

Announcement is made that the new Kingsbury hot blast heater, invented by William M. Kingsbury, heating and ventilating engineer for the Board of Education, in Cleveland, Ohio, will be ready for the market about July 1, 1915. This heater, which is made of cast iron, was illustrated and described in THE HEATING AND VENTILATING MAGAZINE for August, 1913. Since that time, it has undergone extensive tests. A company has now been formed to market the heater. A catalogue is in course of preparation which will be issued about June 1.

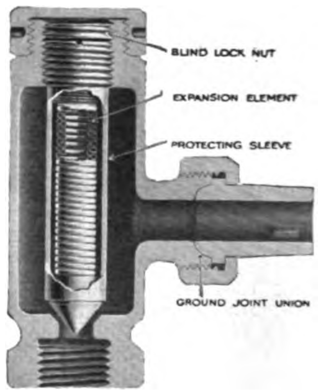
O. L. Remington, general manager, and H. P. McColl, engineer for Wm. McLean & Co., Melbourne, Australia, are now in this country investigating methods, machinery and new developments in the field of heating and ventilation. Messrs. Remington and McColl, who have been stopping at the La Salle Hotel in Chicago, are visiting all of the principal industrial centers in the East before going to England.

NEW DEVICES

The Winn Steam Trap.

The accompanying illustration shows the Winn steam trap, which has been on the European market for many years under the name of the Welo trap and is now being manufactured in the United States. It is for use with vacuum, vapor and modulation systems of heating. The trap is built on the thermostatic principle which makes it positive in its operation.

Some of the features are long expansion element, seamless corrugation, large discharge opening and non-collapsible expansion element.



THE WINN STEAM TRAP.

These features are designed to give large capacity, durability, and efficiency. The trap is self-cleaning and is claimed to be noiseless in operation.

The trap consists of an outer casing made entirely of brass. The valve seat forms an integral part of the casing. The casing has a ground joint union tail piece for attaching it to the heating unit. In this casing a sensitive expansion element is inserted.

The expansion element consists of a seamless corrugated bronze tube, which is filled with an expansion liquid. The valve head is attached to this tube, and when steam comes in contact with it the liquid inside expands and pushes the valve head to its seat. As soon as water collects around the tube the liquid contracts, and the valve opens, permitting the water to pass through freely into the return line. The valve works automatically, thus requiring no attention after being installed. The protecting sleeve guides the valve head to its seat, and protects the corrugated element against scale and dirt.

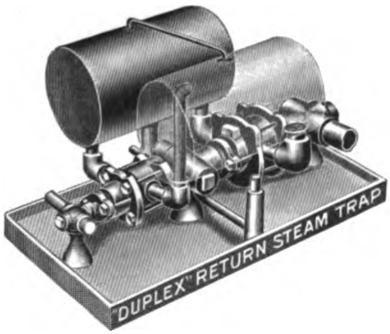
These traps are manufactured and sold by the Detroit Steam Specialty Co., Kerr Building, Detroit, Mich., and are described in detail in the company's "Bulletin A."

New Publications.

EVERREADY PIPE AND ELBOW CHART, by M. W. Pehl, is an ingenious little calculator, made of celluloid, containing full instructions for quickly and accurately laying out and cutting all kinds of elbows, pipe and ventilation work. The chart is accompanied by a 54-page book of instructions and tables for sheet metal workers, boiler makers, etc. Size of instruction book (celluloid chart being contained in pocket at back of book) 4½x6¾ in. Price $1. May be had from the book department of THE HEATING AND VENTILATING MAGAZINE.

Trade Literature.

DUPLEX STEAM TRAP AND BOILER FEEDER is featured in a recent circular of the Duplex Steam Trap Mfg. Co., Detroit, Mich. This machine is stated to be the first ever manufactured that will feed the boiler direct from the main or other sources, discharging a continuous stream of water to the boiler. The

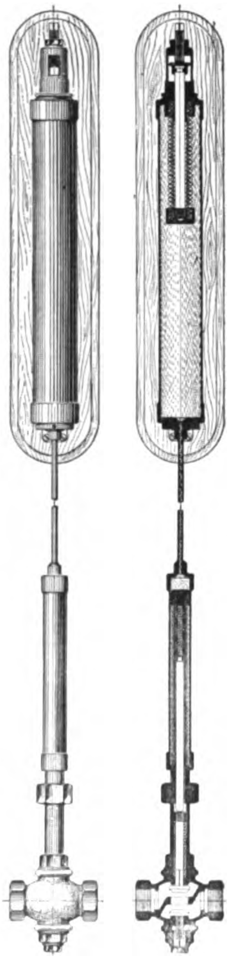


DUPLEX RETURN STEAM TRAP.

water passes through a heater, is heated by exhaust from the engine and put into the boiler at any temperature, thus dispensing with pumps and injectors. By referring to the illustration it will be seen that the trap does not stand still to fill and the same to empty, but when one tank is filling the other is emptying, thus giving the continuous water stream. The apparatus is made without floats, springs, levers or weights.

GOLD'S ELECTRIC THERMOSTATIC CONTROL OF STEAM HEATING as applied to a railway car, is described in a circular of the Gold Car Heating & Lighting Co., to which is added a test of the Gold thermostatic control as compared with the Gold straight steam heating system. In addition to securing a more even temperature with the control system the steam saving ran from 41% to 83%. The company manufactures the Gold temperature regulating system for use in buildings, operated entirely from the lighting circuit.

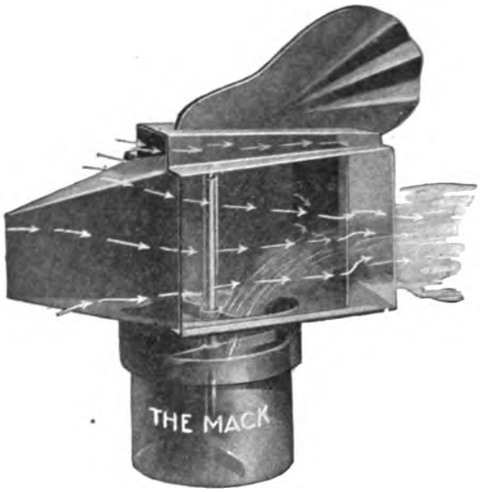
SARCO TEMPERATURE REGULATORS (Samson Patents), including heat regulating devices of all kinds and Sarco thermostatic controllers, are described in circular matter published by the Sarco Engineering Co., New York. Among the interesting devices shown is the Sarco



SARCO ROOM TEMPERATURE REGULATOR.

room temperature regulator which is especially adapted for office buildings, etc., where a uniform temperature is desired. It does not require electricity or compressed air and has no clockwork or diaphragms. Apart from its operating fluid it is constructed entirely of metal. It is made with valve sizes from ⅜ in. to 4 in. in diameter.

Mack Ejector-Ventilator, manufactured by the McDonald Bros. Co., Swetland Building, Cleveland, O., is a new device described in recently-issued circular matter. It is described as not only weather-proof, but a real ventilator, doing its work at all times and under all conditions. It has been found that the low and rarely measured velocity of 2½ miles per hour is sufficient to create a suction

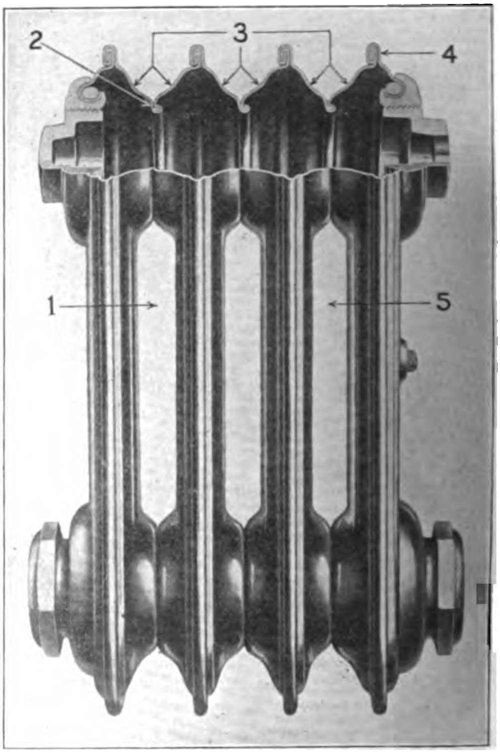


MACK EJECTOR-VENTILATOR.

in the Mack ventilator. In operation, the wedge, always pointed into the wind, deflects the current into three separate horizontal ducts, which cover the head. These ducts, decreasing in size toward the discharge ends, compress the current so that it discharges at high velocity. This powerful ejector-discharge generates a continuous partial vacuum inside the head, causing a strong suction in the stack, independent of temperature. With this device it is claimed that down-draft or back pressure of outside air is impossible, while heavy gases and cold air are lifted and discharged. Care is taken to provide freedom of motion and noiseless operation by using an inverted bronze cone-bearing. The Mack ejector-ventilator is made in 14 sizes, with capacities ranging from 4,300 to 374,000 cu. ft. air displacement per hour.

Ford Steam and Water Specialties, comprising the product of the Thomas P. Ford Co., Inc., 407 Broome St., New York, are featured in a new and attractive catalogue. Among the devices shown and described are improved damper regulators (high and low pressure), compound steam traps, reducing valves (steam, air and water), pump governors and pressure regulators, balanced tank valves, fire line reducing valves, by-pass valves, controlling devices and relief valves. The catalogue refers with pride to the fact that this line has been on the market for 23 years without interruption. Under the heading of "To Get Acquainted," the catalogue contains some timely remarks regarding the general subject of facilities, deliveries and guarantees. Size 5¼x8 in. Pp. 32.

Presto Sanitary Radiators, for residences, apartments and public buildings, featuring their sanitation, durability and quick uniform heat distribution at low fuel expense, are the subject of a newly-issued catalogue published by the Pressed Metal Radiator Co., Pittsburgh, Pa. This well-known radiator, due to its construction of pressed metal in place of cast-iron, occupies one-fourth less space and weighs one-third the amount of other types. On account of its light weight it can readily be attached to the wall, giving a free, unobstructed floor space. It is also pointed out that the wide space between sections gives ready access to every part and the smooth surfaces may be easily dusted. In rooms



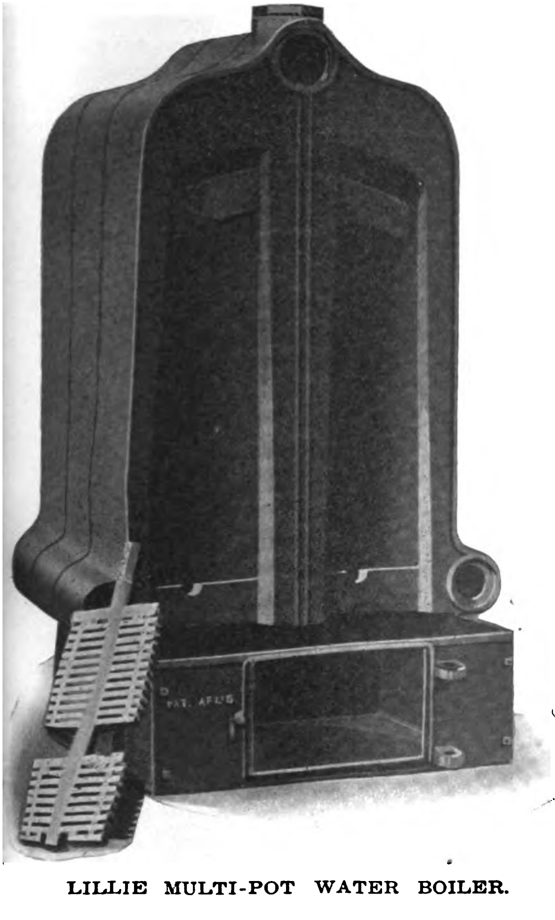
CONSTRUCTION OF THE PRESTO RADIATOR.

likely to become overheated or requiring quick heating up, this type is especially recommended by the manufacturers due to the rapidity with which the radiator heats and cools. The catalogue includes a display of typical buildings in which Presto radiators

are installed. A broken view of a typical radiator shows its details of construction.

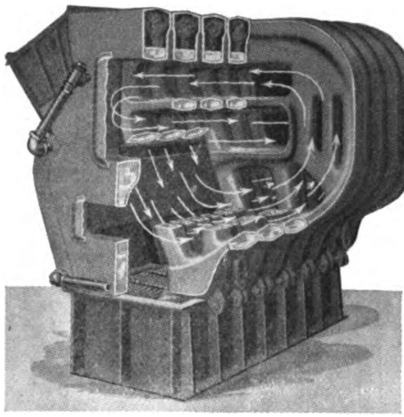
(1) represents the wide air spaces to provide uniform heat distribution; (2) shows the metal-to-metal air-tight inner seam; (3) shows the special anti-corrosive metal of uniform strength and thickness throughout; (4) indicates the double thickness of outer seam, to secure rigidity and durability; while (5) shows the easy cleaning feature, due to the wide spacing of the sections. Views are also presented in the catalogue of the company's plant in West Pittsburgh, including interior views of the press department and expanding department. Size 6 x 9 in. (standard). Pp. 16.

LILLIE'S MULTI-POT BOILER is the title of a refreshing catalogue published by the Multi-Pot Boiler Co., Denver, Colo., which starts off with some "straight jabs" about boiler manufacturers' catalogues, and continues to expound, in a breezy manner, their various shortcomings. Regarding a rating based on a hard coal test, for instance, the opinion of this writer is that it "is about as useful to a soft coal user as a test made on an old cheese." The Multi-Pot steam and water boilers are shown and described and the ratings are given for "fair draft chimneys," "good draft chimneys," and "strong draft chimneys." Size 3½x6 in. (standard). Pp. 12.



LILLIE MULTI-POT WATER BOILER.

PIERCE DOWN DRAFT BOILER, containing the features of the down-draft principle, smoke consumption, magazine feed, self-cleaning surface and adaptability for burning and kind of fuel, is featured in a recent circular published by the Pierce, Butler & Pierce Mfg. Corp., Syracuse, N. Y. The distinguishing feature of this heater is the arrangement of the combustion chamber and the course followed



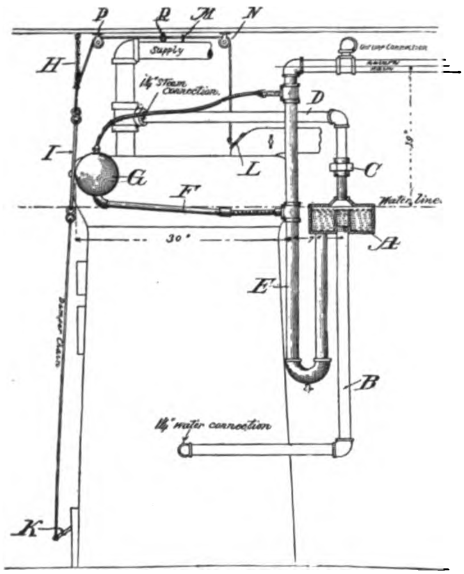
PIERCE DOWN-DRAFT BOILER.

by the fire travel. The draft coming from above the fresh coal, carries the gases down and through the fire, so that the boiler is comparatively smokeless in operation. This boiler is furnished for either steam or hot water heating and is made in a wide range of capacities.

THE STORY OF THE PLUMFOOL WHO CONFESSED, which is being published in serial form by the International Heater Co., Utica, N. Y., contains, in the latest edition, "Pop's Story," which is the third of the series. It is well worth reading.

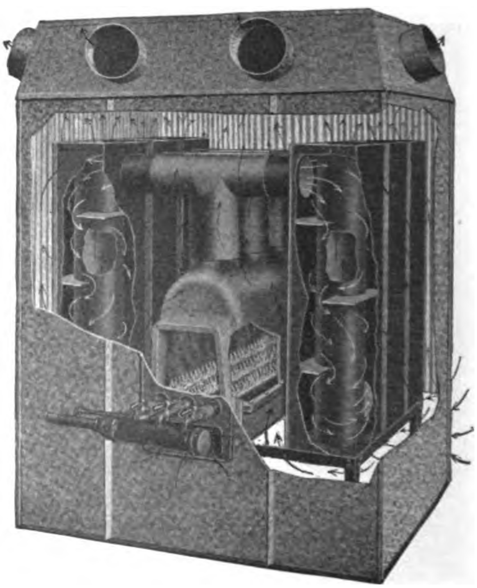
SOME SAVING SENSE ON HEATING AND THE LAST LAUGH are titles of two well-gotten-up circulars, published by the Kelsey Heating Co., Syracuse, N. Y., and explaining how Kelsey heat differs from the usual hot air heat. One of the typical installations shown is of the Kelsey humidifier and water supply tank, as attached to the heater. In the circular on "The Last Laugh," a full set of floor plans are reproduced of a Kelsey heated residence, showing the location of the warm air inlets and foul air exits.

Modern Heating for the Home, devoted to the Hutchison system of vapor heating, described as the most efficient and economical heating system ever devised, is described in a catalogue issued by the Hutchison Vapor Heating Corporation from its new headquarters, the Woodward Building, Washington, D. C. The principal devices of this system consist of the Hutchison vapor valve, Hutchison damper regulator and Hutchison trap-receiver. The interesting feature of the trap-receiver, which comprises a single casting, is that it maintains an even water line in the boiler. It delivers the condensation to the bottom of the boiler, is designed absolutely to prevent water backing in the returns, and acts as an auxiliary safety valve. It is stated that by its use all thermostatic, float and check valves are eliminated and there are no movable parts in the returns from the radiator to the boiler. The operation of the Hutchison damper regulator and trap-receiver may be seen by referring to the accompanying illustration. It will be noted that the trap-receiver is connected from its top with the supply main and from its bottom with the return opening in the boiler. The top of the trap-receiver is placed on a level with the water-line, therefore the water stands in the pipe B on a level with the water in the boiler. The condensation from the return main flows down pipe E around the bend in trap-receiver A where it overflows into pipe B, returning to the boiler. As the vapor pressure rises in the boiler, the water remains in pipe B on the water-line with the boiler, while the water in trap-receiver A is forced downward through the return bend and up pipes E and F into the regulator globe G. The additional weight of water in globe G causes same to lower, closing front damper K and opening check draft L, thereby retarding combustion. As the pressure lowers in the boiler, the water will flow from globe G back through pipes F and E into the trap-receiver and the globe G, being lightened, will rise to its former position by action of spring H. This action continues until the damper regulator automatically adjusts itself to allow only sufficient combustion to supply the demands on the boiler. Complete directions for connecting and adjusting the Hutchinson system are contained in the catalogue. Size 6¼x9¼ in. Pp. 16.



TRAP-RECEIVER AND DAMPER REGULATOR FOR THE HUTCHISON SYSTEM OF VAPOR HEATING.

Columbus Gas Furnace, for residences, schools, churches, stores, etc., manufactured by the gas furnace department of the Columbus Heating & Ventilating Co., Columbus, O., is a notable type of heater which is illustrated and described in a well gotten up circular, just issued. The manufacturers state this heater has been developed after years of experiment and that due attention has been paid to the economical consumption of fuel as well as to the manner in which the furnace is constructed. It is emphasized that in this heater all the heat comes directly in contact with the radiating surface, evenly divided, producing an intense heat. All joints and seams are spot welded

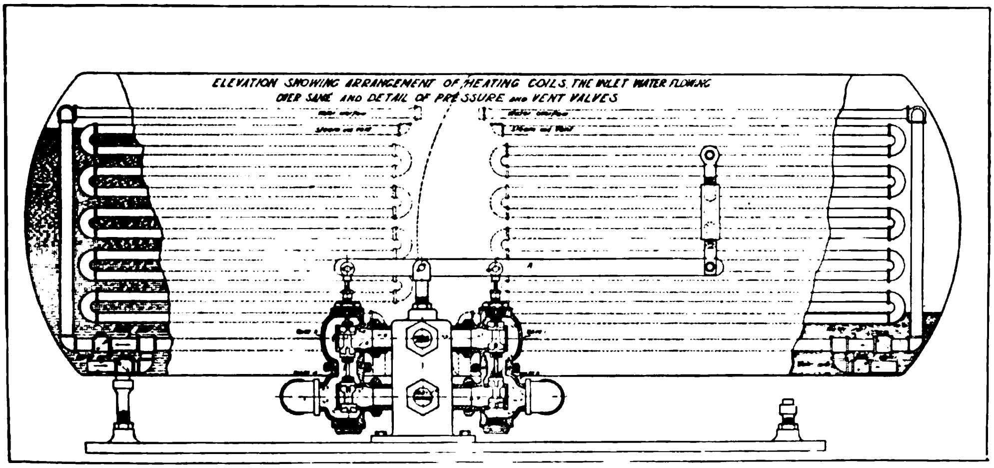

SECTIONAL VIEW OF COLUMBUS GAS FURNACE.

with an electric welder, or double seamed by special machinery to insure tight connections. The construction of the heater makes it necessary that the products of combustion or hot gases must travel the entire circuit of the radiators before reaching the pipe to the chimney. The Columbus gas furnace is made in three sizes, varying from 30 in. deep to 45 in. deep. The other dimensions are the same in all sizes, namely, 48 in. wide and 66 in. high. The company's guarantee, which accompanies the circular, states that when properly installed the Columbus gas furnace "will heat and ventilate the halls, rooms and chambers in which there are register connections with the furnace, to an average temperature of 70° F. in zero weather."

Power and Heating Plant Condensation Utilities, made by the F. C. Farnsworth & Co., Bush Terminal, Brooklyn, N. Y., are presented in a well-designed catalogue. They include the Farnsworth duplex combined boiler feed, feed-water, heater, receiving tank and weighing apparatus, which is described as packless, automatic, of positive action and giving continuous flow; also the Farnsworth positive acting, double seal, water balanced, packless steam trap or blow-off tank, and the Farnsworth positive acting, double seal, water balanced, packless three valve lifting trap and condensation weighter. Elevation and plan views of the heater and receiving tank show in detail the principle on which the apparatus is built. Each compartment of the tank is connected separately with the water or condensation pipes. The water is collected alternately through the receiving check valves, and thence through flexible copper hose connections leading to the bottom of each compartment of the tank. The water is delivered from the bottom of each compartment of the tank alternately, through the hose connections and through the delivery check valves. The receiving and delivery process into each of the compartments alternates as the tank oscillates, reversing the steam and vent valves which are connected to each compartment of the tank by flexible copper hose, and a pipe extends to the top of each compartment to apply the steam pressure directly on top of the water The insertion of a copper coil in each compartment makes the tank also a feed-water heater. Size 6x9 in. (standard). Pp. 20.

Kinealy Air Conditioning Apparatus, which is now being marketed by the Consolidated Engineering Co., Chicago, Ill., is the subject of a new catalogue devoted to the Kinealy air washer and its accessories. The views show the latest types of this apparatus, including the present construction of the Kinealy self-cleaning mist nozzle and self-cleaning spray head. A full set of dimensions are included for the Type A apparatus. Size 8½x11 in. (standard). Pp. 8.

Sirocco Products, covering generally the entire air-conditioning product of the American Blower Co., Detroit, Mich., is the title of a notable publication of handsome design and unusual attractiveness. It is profusely illustrated with types of the company's apparatus, typical buildings equipped with Sirocco systems and photographic diagrams of heating and ventilating layouts, showing the installation and operation of the various units. The products include fan systems of heating and ventilating, fan systems of cooling and ventilating, drying systems, mechanical draft apparatus, blast equipment, automatic return steam traps and vertical enclosed self-oiling steam engines. Size 8½x11 in. (standard). Pp. 32.



FARNSWORTH DUPLEX COMBINED BOILER-FEED, FEED WATER HEATER, RECEIVING TANK AND WEIGHING APPARATUS.

WEBSTER MODULATION SYSTEM OF STEAM HEATING, is the title of a catalogue of remarkable attractiveness, just published by Warren Webster & Co., Camden, N. J. The Webster modulation system is described in detail, and emphasis is laid on the fact that the company's 27 years' experience in low-pressure steam heating and its facilities in organization and manufacturing, combined with the standing the company has attained in this field, are sufficient guarantees of the success of the Webster modulation system. The devices used with this system are taken up in order and the typical layouts shown are carefully drawn so that each part and connection may be easily noted. A large portion of the catalogue is given over to an imposing array of buildings in which the Webster system is installed. Size 8x10 in. Pp. 88.

New Vacuum Heating Catalogue.

An unusually complete and readable catalogue on vacuum and vapor heating equipment, with especial reference to the Reliable heating specialities, has been issued by the Bishop-Babcock-Becker Co., Cleveland, Ohio, and is now ready for distribution.

OWNERSHIP NOTICE.

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None.

(Signed) A. S. ARMAGNAC, Editor.

Sworn to and subscribed before me this 11th day of March, 1915.
(Seal) (Signed) A. L. SCANTLEBURY, No. 64.
Notary Public, Kings County, Certificate filed in New York County.
(*My commission expires March* 30, 1915.)

ADVERTISERS' INDEX

The Heating and Ventilating Magazine

1123 Broadway | NEW YORK | June, 1915

Heating and Ventilating an Office Building by Electricity

NOVEL EQUIPMENT FOR THE HYDRAULIC POWER CO.'S PLANT AT NIAGARA FALLS, NEW YORK.

By C. F. Herington.

There has recently been completed at Niagara Falls, N. Y., a new office building for the Hydraulic Power Co. The office building is built of rough stone and is so situated on top of the cliff just below the Falls that at times it lies directly in the path of an 80 mile an hour gale.

The power plant, containing the generators and other machinery, is located approximately 230 ft. below the office and intake building, as shown in Fig. 2, the office building being to the right and top of the picture, with the flag on top of the elevator tower. All of the stone

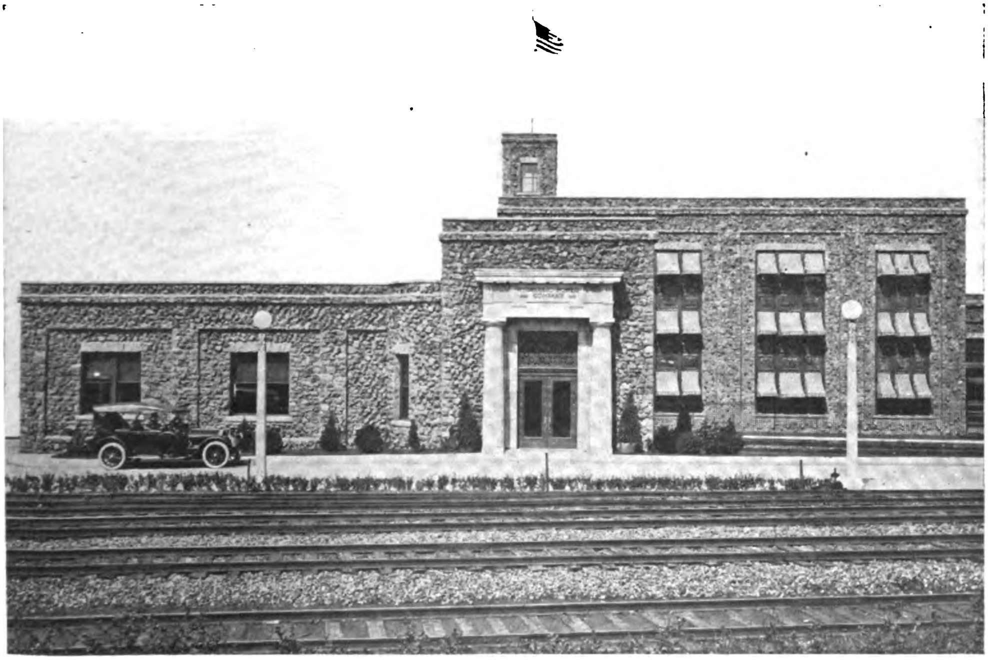


FIG. 1—OFFICE AND INTAKE BUILDING, PLANT OF HYDRAULIC POWER CO., NIAGARA FALLS.

used for constructing the buildings was excavated from the canal, which extends from the power plant through the streets of the city to a point about one mile above the Falls.

This company furnishes mechanical power to factories and other industries located in Niagara Falls only, and, as the cost of electricity generated at Niagaga Falls is exceedingly low, the company decided to take a new and novel step and heat their office building throughout by electricity.

trates only one section, however. The heater itself is made up of 10 such sections, and by a simple arrangement can be lowered through the platform upon which it rests by a trap-door placed directly underneath it.

After going through the coil heater, the air is drawn through a Bicalky air washer, having a capacity of washing 15,000 cu. ft. of air per minute; details of the air washer are shown in Figs. 7, 8 and 9.

Fig. 9 shows a longitudinal section

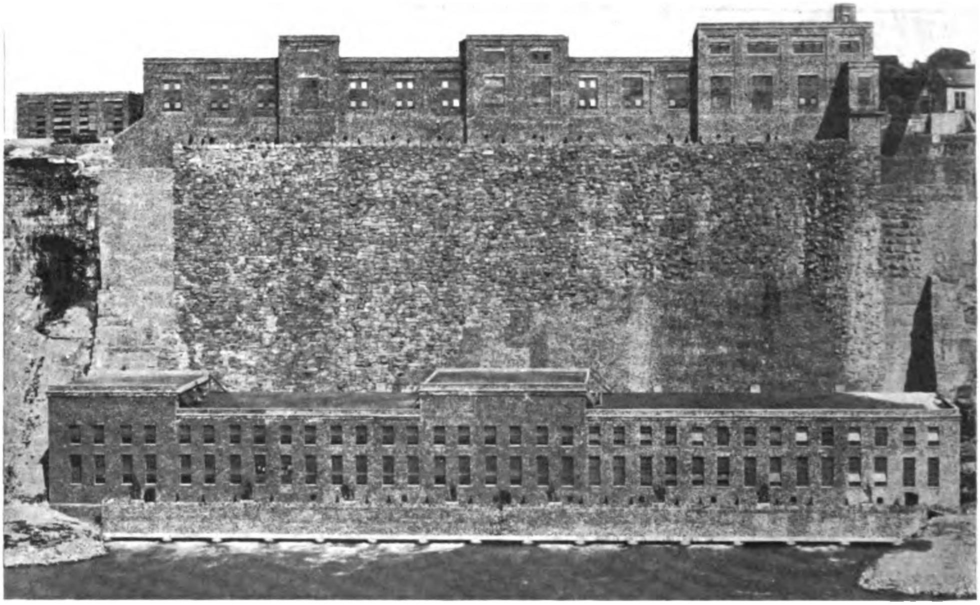


FIG. 2—POWER PLANT OF HYDRAULIC POWER CO., AT BASE OF CLIFF, NIAGARA FALLS.

Fig. 3 shows a plan of the piping, which was run in a place especially designed for that purpose, as shown in a sectional elevation, Fig. 4. Note how the air is carried up and across the intake bay and machine shop, and then dropped down to heat the floors below that level. This is only one of the novel features of the design.

Referring again to Fig. 3, the air is taken directly in through a part of the louvre window marked "E" on the plan, and is drawn in and through the sectional electric coil heater, a detail of which is shown in Fig. 16, which illus-

through the air washer, looking directly in the direction the air is passing through the washer. In this figure "A" represents the priming pipe, which gives two sources of supply, one to the pump and the other to the tank in the air washer. "P" represents a centrifugal pump of the Economy Pumping Machinery Co.'s make, and has a capacity of 185 gals. per minute, at a speed of 1,100 r.p.m. It is driven by a 3 H.P. motor. "S" is the suction pipe, which is 3 in. in diameter, and which projects inside of a round revolving screen "F," covered with No. 24 brass mesh screen. Inside of this re-

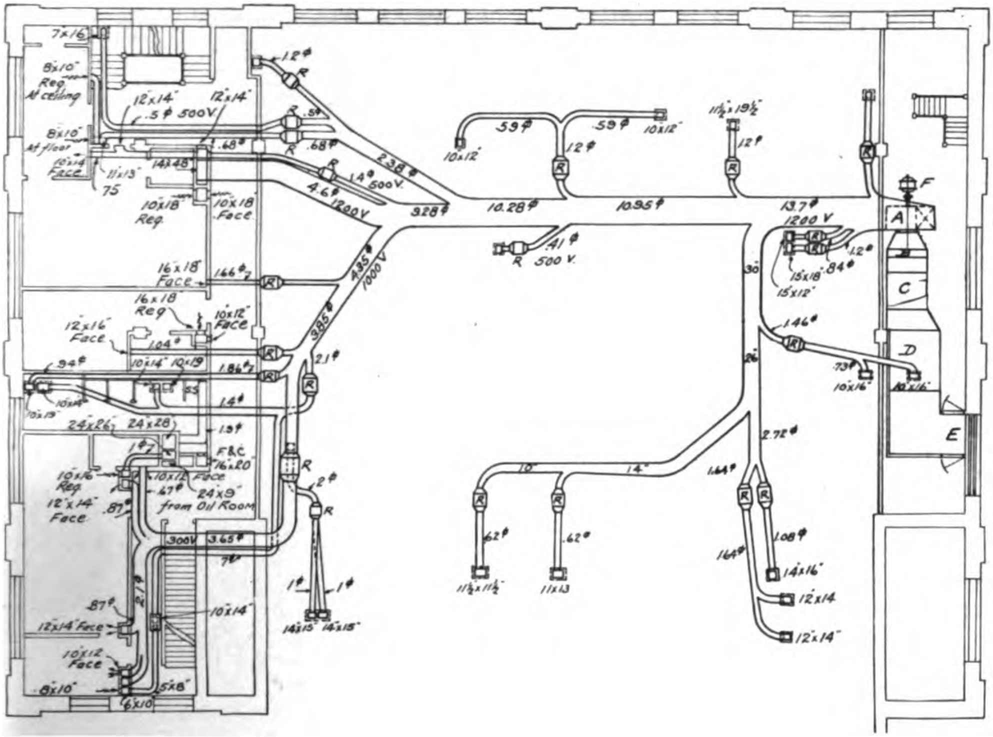


FIG. 3—PLAN OF AIR PIPING IN OFFICE BUILDING OF HYDRAULIC POWER CO., SHOWING LOCATION OF ELECTRIC HEATERS.

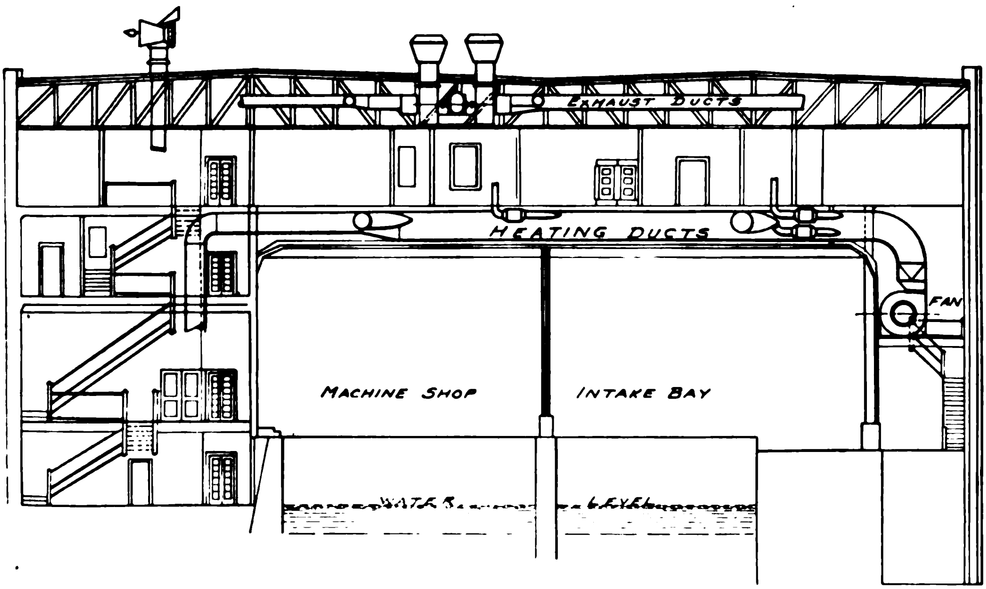
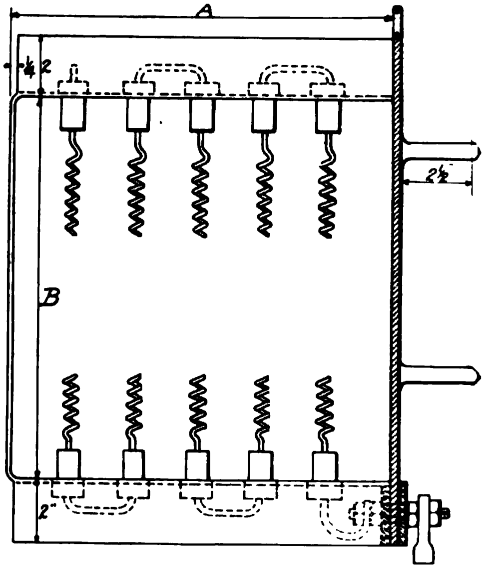


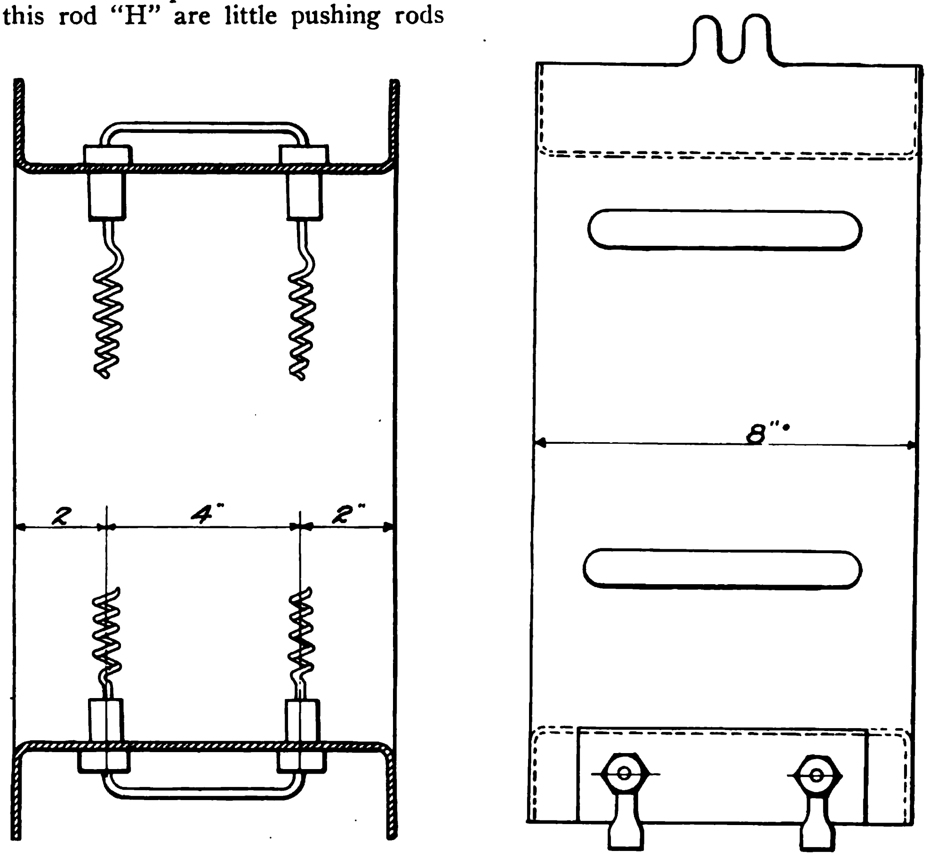
FIG. 4—SECTIONAL ELEVATION OF OFFICE BUILDING OF HYDRAULIC POWER CO., SHOWING ARRANGEMENT OF AIR PIPING.

volving screen, as shown on the drawing, there are placed several spray valves or nozzles similar to the ones marked "J," which are used to keep the small particles of dust and dirt away from the screen, so that the pump is drawing clean water through its suction pipe.

By referring to Fig. 8, it will be noted how this screen "F" revolves. "C" represents small galvanized iron buckets, and as the water drops through the spray nozzles "J" the buckets become filled and overturn, which revolves the camshaft "G" (Fig. 9), which in turn revolves the screen by means of a sprocket chain "K."

The nozzles "J" are spaced as shown in Fig. 9, and back of each row of nozzles is placed a spray nozzle flushing rod marked "H," which is connected to the camshaft by means of a roller "R," which, running upon the cam, has a vertical movement up and down. Attached to this rod "H" are little pushing rods





FIGS. 5, 6—DETAILS OF ELECTRIC COIL HEATER, PLANT OF HYDRAULIC POWER CO.

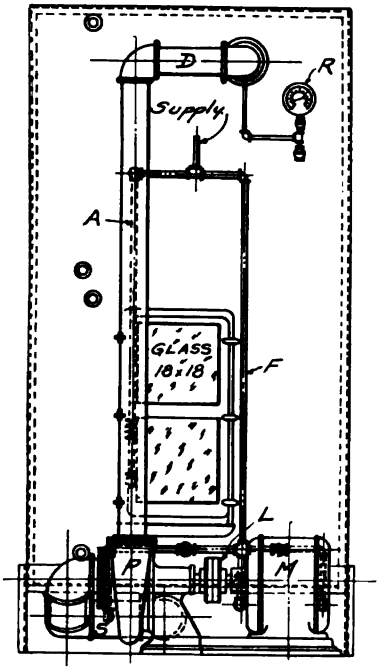


FIG. 7—OUTSIDE VIEW OF AIR WASHER, SHOWING PUMP AND MOTOR.

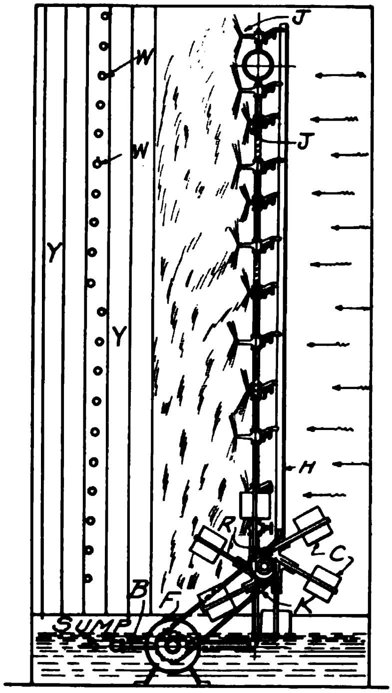


FIG. 8—DETAIL SHOWING METHOD OF REVOLVING SCREEN IN AIR WASHER.

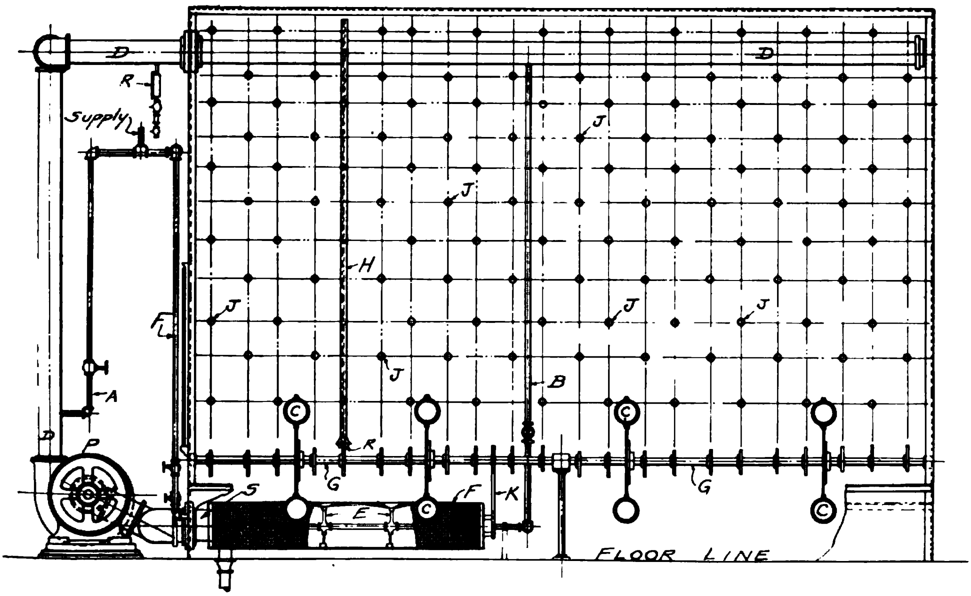


FIG. 9—LONGITUDINAL SECTION THROUGH AIR WASHER.

behind each spray nozzle, which push out the sprays, so that the force of the water coming behind them cleans out particles of dirt. As the cams are so fixed on the shaft "G" that no two vertical lines of nozzles are being cleaned at the same moment, the cleaning process does not interfere with the washing of the air.

"B" in Figs. 8 and 9 indicates the screen flushing water pipe taken from the main discharge pipe "D" and supplying the spray nozzles in the revolving screen "F." In Fig. 8 "W" represents the humidifying coils and "Y" the eliminator plates. Fig. 7 is an outside view of the air washer showing the pump "P" and the motor "M," which are connected together by means of a flexible coupling "L," and the discharge pipe "D" having a pressure gauge "R." "A" represents the priming pipe, as in Fig. 9, and in the washer there is a large glass door, as shown, so that easy access can be made into the washer for repairs or examination.

ARRANGEMENT FOR COOLING AIR IN SUMMER.

Another novel feature with this equipment is the method of introducing cold water for cooling purposes in the summer. Referring to Fig. 9, pipe "B," which leads from header "D" to strainer, has a valve; this valve is closed in summer and valve opened in pipe "F," which leads to the nozzles "E" inside of pump suction strainer. In this way the fresh cold incoming water surrounds the pump suction pipe and after passing the suction strainer is drawn into the pump and discharged through the nozzles "J" to wash the air.

With this method the fresh water supplying the air washer does not come in contact and mix with the balance of the water in the sump, but is immediately drawn into the pump and discharged at the nozzles "J," thereby being at a much lower temperature than the balance of the water in the sump. This brings the air passing through the air washer to a much lower temperature than has been heretofore accomplished with air washers and adds no additional expense.

After passing through the air washer "C" and going through the humidifier "B," as shown in Fig. 9, the air is drawn into the fan "A," which is a No. 9 Bi-Multi, and is driven by a 5 H.P. 250 R.P.M. motor "F." The air is discharged into ducts at a temperature range of 50° to 80° F., while the velocity at the discharge outlet of the fan is approximately 1,200 ft. per minute. From these ducts the air is carried through this pipe space (Figs. 3 and 4) and dropped to the different offices, where it enters the rooms through register faces at a height approximately 7 ft. above the floor. At the time the air enters the offices it has lost some of its temperature

FIG. 10—ONE OF THE PRIVATE OFFICES, HYDRAULIC POWER CO., SHOWING AIR SUPPLY AND VENT REGISTERS.

due to friction and other air losses, so that it is about 50°.

INDIVIDUAL ELECTRIC REHEATERS.

The occupant of each office has a thermometer hanging on the wall and whatever temperature he desires, according to the weather outside and the location of his office in regard to the prevailing winds, is obtained by pressing a button switch in the wall and in a few minutes the air is reheated just before it enters the office by an electric coil heater containing one or more sections of the coil shown in Figs. 5 and 6. The location of reheater coils are shown and designated by the letter "R" in Fig. 3.

In Fig. 5 the dimension marked A has three different sizes as 12, 18, 24-in., while B is 12, 15, 24-in. for its corresponding dimensions, as different sizes of heater are required for the different size rooms.

In Figs. 10 and 11, which are photographs of two of the private offices, the register faces for the incoming air are shown one on each side of the clock, while the vent faces are shown, two above the heat registers, and two near the floor in the fireplace (Fig. 10). The floor vent faces cannot be seen in Fig. 11, but they are the same height above the floor as in Fig. 10 and in the same position as the upper vent faces. Referring to Fig. 10, the upper vent faces have registers, which in the winter time are always kept closed, while the lower vent faces have no register faces, and the air flows out into the corridors (Fig. 12), with the result that the corridors are heated by the air, which is drawn from the outer offices. The corridors have a register face which is connected to a duct, and the air is drawn out by the fans in the attic space as shown in

FIG. 11—ANOTHER PRIVATE OFFICE, PLANT OF HYDRAULIC POWER CO., ALSO EQUIPPED WITH AIR SUPPLY AND VENT REGISTERS.

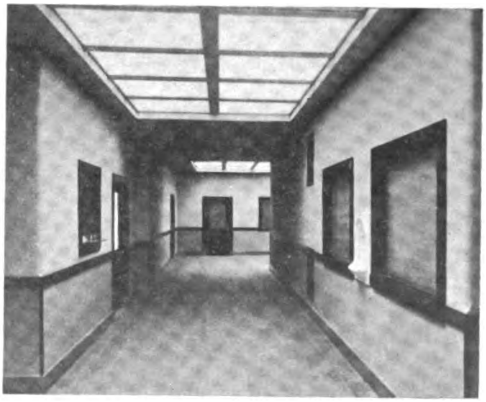


FIG. 12—VENT REGISTERS IN CORRIDOR, HYDRAULIC POWER CO.

Fig. 4, and discharged out through the ventilators on the roof as shown in detail in Fig. 15. This is a detail of the specially designed hood through which the exhaust air from the fans passes to the atmosphere.

There is no heat put in the corridors except through the vent outlets from the offices, with the exception of two places, where there are large stair wells and heat is required.

THE AIR COOLING SYSTEM.

The upper vent registers, which are closed in the winter time, are connected to ducts, which in turn are connected to the fans in the attic space, so that in the summer time the offices have all the vents opened. The hot air is drawn out through the top vent faces and the corridors draw out the air through the vent faces. Of course, the electric heaters are not used in the summer time and are dropped out of the way. The fan takes the comparatively cool air from the top of the cliff, and this air is drawn through the air washer and further cooled by coming in contact with the water, so that the heat registers in summer time are discharging into the offices and rooms cool and washed air, and the fans are drawing out the hot air, thereby maintaining ventilated offices without the use of electric fans.

The toilet rooms take their heat from the corridors through registers at the floor line and each toilet room is connected to the exhaust fan in the attic space by a duct running back of each closet. An outlet is placed just back of the seat and outlets are also placed about 8 ft. above the floor, so that the ultimate result is a constant changing circulation of air through the toilet rooms, leaving no chance for any odors to accumulate.

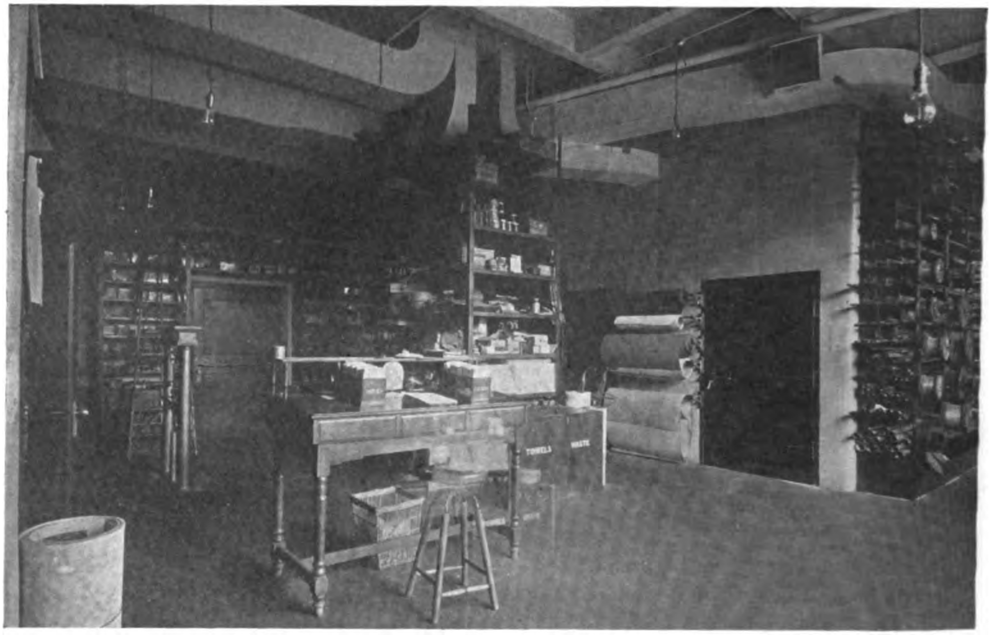


FIG. 13—SOME OF THE DUCT WORK IN PLANT OF HYDRAULIC POWER CO.

In the slop room off each corridor there is placed directly above the slop sink in the ceiling a vent face connected to the exhaust fans in the attic space, so that there is no odor in this room, nor does any escape in the corridor. This is another one of the novel features in the design of this system.

In Fig. 13 there is shown a photograph which gives one a very good idea of the splendid duct work which was done throughout the job. The writer has never seen any better sheet metal work than

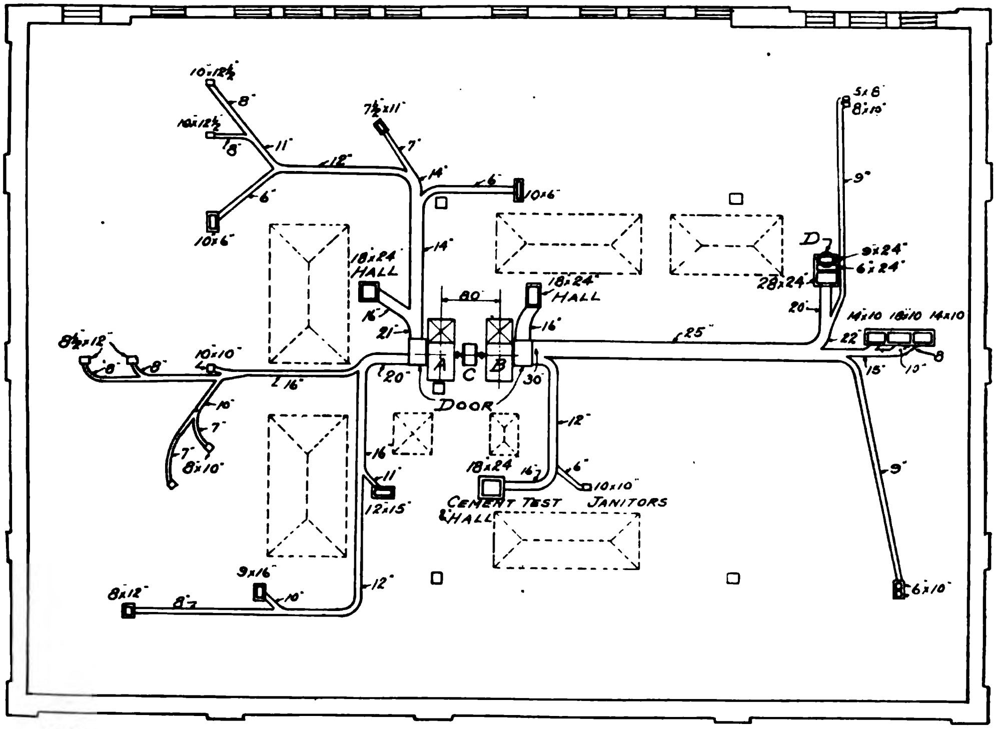


FIG. 14—EXHAUST VENTILATING SYSTEM, PLANT OF HYDRAULIC POWER CO.

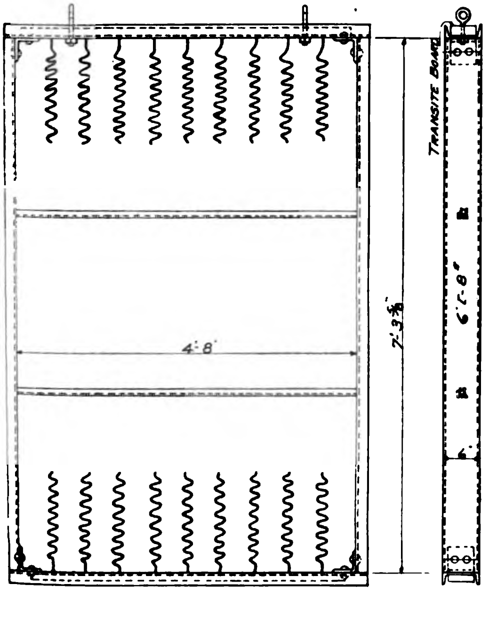


FIG. 16—DETAIL OF SECTIONAL ELECTRIC COIL HEATER IN THE AIR INTAKE.

that in this plant. In the picture there is shown the storeroom and the door to the right is the door leading to the oil room, which is air-tight, with a duct, which can be seen, leading out of the room. This duct goes directly up through the roof, where it is connected to a Bicalky 24-in. roof fan ventilator, so that the oil room is fireproof in every way. The location of this ventilator is shown in Fig. 14 and the elevation in Fig. 4.

Fig. 14 shows a plan of the exhaust

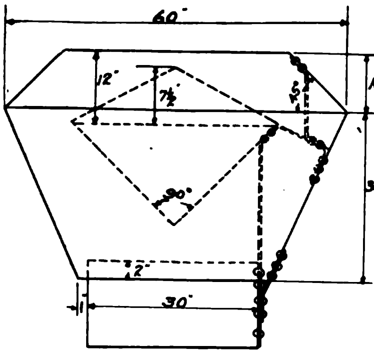


FIG. 15—DETAIL OF ROOF VENTILATOR.

system and is self-explanatory. The fans "A" and "B" are special double 60-in. fans, direct connected to a 5 H.P. 220 volt motor "C" running at 385 R.P.M. Fan "A" has a capacity of exhausting 5,000 cu. ft. of air per minute, and fan "B" has a capacity of 6,000 cu. ft. of air per minute. Each branch connection of duct is provided with a lock regulating damper.

In conclusion it should be mentioned that this system of heating and ventilating has been in operation for two years and is giving perfect satisfaction.

The contractor for this work was the Bicalky Fan Company, of Buffalo, N. Y., and the entire work was designed and installed under the personal supervision of C. H. Bicalky, president of the company.

The writer takes this opportunity to thank John L. Harper, chief engineer; Geo. R. Sheppard, mechanical engineer; O. D. Dales, designing engineer, and M. E. Chesbro, all of the Hydraulic Power Company, for the courtesies extended to him in the preparation of this article.

The Cost of Schoolhouse Construction

WITH A PROPOSED UNIT BASED ON CUBICAL CONTENTS.

By EDWARD C. BALDWIN,

Business Agent, Massachusetts Board of Education.

(*From a paper read before the National Association of School Accounting Officers at St. Louis, May* 19, 1915.)

It is said that the expenditure for new schoolhouses in the United States is about $102,000,000 annually, and the cost of repairs on old buildings is in excess of $35,000,000 annually.

The employment of architects and of engineers is no small part of the work of a school board or committee. Most of these boards and committees are made up of men and women who, although they are representative members of the community, have no data available regarding comparative costs, and it is a perfectly easy matter for an architect or an engineer to get their approval on extravagant propositions. It frequently happens that both the architect and the engineer are influenced by the extravagant notions of the school officials who demand equipment and facilities in excess of their needs. Ultimately the cost of all of these things must show in the total cost of the building, and if this, in turn, is reduced to a cost per cubic foot which can be compared with the cost of similar buildings in other communities the extravagance would be exposed.

The principal task set for me is to suggest definitions of certain units of cost of schoolhouse construction and repair, and a plan whereby these units may be used in the everyday work of accounting.

It is now almost impossible to compare the work of one architect or engineer with that of another, or to measure in precise terms the results of their efforts. When an attempt is made to compare the cost of one building with the cost of another, we often find ourselves utterly helpless because of the lack of a unit of measurement which is uniform, standard and generally accepted (the same in one place as in another). The object of this paper is to suggest such a unit, and to urge its adoption.

CLASSIFICATION OF SCHOOL BUILDINGS.

The first step necessary towards this end is to classify our buildings by types according to use, then by types according to construction.

A. *According to Use.*—In elementary school work there are two types of buildings which we may call Elementary "A," and Elementary "B." *Elementary "A"* is a building used for lower and upper elementary grades only. *Elementary "B"* is a building used for lower and upper elementary grades, but in addition to the regular classrooms contains rooms for manual training, cooking and assembly hall or gymnasium.

Secondary schools may be grouped as follows:

High "A," a classical high school. A building containing ordinary class and recitation rooms and laboratories for elementary sciences, usually with hall and library.

High "B" a commercial high school. A building containing ordinary class and recitation rooms, rooms with special equipment for commercial branches, usually with hall, library and museum, and laboratories for elementary sciences.

High "C," a technical high school. A building containing in addition to ordinary class and recitation rooms, rooms with special equipment for household and industrial arts and equipped with special machinery or apparatus for the teaching of the principal technical branches required.

High "D," a suburban high school. A building which combines any or all of the features of High "A," "B," and "C."

High "E," a rural high school. A comparatively small building designed for the small or rural community which will contain classrooms, library, science rooms, etc.

Normal "A," a normal school. A building containing ordinary class and recitation rooms, usually with hall, library and elementary science rooms, used for the training of school teachers.

Note: All of the above, except High "E" may contain assembly hall, or gymnasium, or both.

Frequently in a modern rural school there is a general study room fitted with movable seats.

Dormitory "A," adapted for students' living quarters, containing sleeping rooms, baths, living rooms, parlors, library and office.

Dormitory "B," the same as type "A," but with dining room, kitchen and laundry within the building.

Dormitory "C," the same as type "A," but with dining room, kitchen and laundry in separate buildings adjoining, or attached to, the dormitory building.

B. *According to Construction.*—These buildings can be divided into three classes according to their construction, and we may call these divisions First Class, Second Class, and Third Class.

A First Class building is one constructed entirely of fireproof material, with nothing inflammable except classroom floors, the tops of which, as well as the trim, casings, and doors, may be of wood, but metal trim is now often used.

A *Second Class* building is one of semi-fireproof construction, with brick, stone, or concrete outer walls, brick firewalls, fire-stopping between all partitions, fireproof stairs and stairways, with wood timbers, rafters and studding and expanded metal or wood laths and plaster partitions, wood floors, casings, doors and trim.

A *Third Class* building is one constructed entirely of wood.

Having thus classified our buildings it will be a simple matter to refer to them as of *High "A," First Class* construction, *Elementary "B," Second Class* construction, *High "E," Third Class* construction, etc., etc.

COST UNIT.

The unit of cost should be the cost per cubic foot, but the method of obtaining cubage should be defined with precision. Upon the question of how the cubage, or cubic feet, should be obtained there are many opinions. Some obtain the cubage by a measurement of the extreme outside dimensions of the building, others by the inside dimensions of the outer walls. Some use the height from the basement floor to the peak of the roof, others to the mean of the roof, others from the top of the foundation to the cornice, and still others from the bottom of the footings to the cornice. Few architects seem to agree as to what is the proper method to adopt in determining the cubage, and because of this disagreement comparisons of cost based upon the cubic foot are often misleading and generally unreliable.

I believe that the standard which we should adopt is the *cubical contents* of the building. This should be defined to mean the cubical contents of the space or the rooms actually used, or available, for school purposes, such, for example, as classrooms, coat rooms, assembly halls, corridors, stairways, play rooms, offices, lunch rooms, sanitaries, storerooms, engine and boiler rooms, coal rooms, stack rooms, fan rooms, etc., but should not include attic spaces, or other

parts of a building which cannot be used for school or its related work.

I fully understand that the acceptance of this standard will not at the outset be unanimous. The fact that architects generally disagree as to the proper way to figure cubage makes this statement easily understood. There may be good reasons advanced by some why the "cubic contents" of a building is not as good a standard as some other, but the time has arrived when a decision should be made, when we should cease our haphazard measures and adopt a standard. It has been left for some one with power to enforce a decision to adopt a standard. The power is here in this organization. It is for us to determine if we are measurably right, then to have the courage to back up that determination.

In adopting a standard for the computing of costs of school buildings we should not be too much concerned as to whether the unit adopted is absolutely accurate, or based upon indisputable scientific principles. The thing we should be concerned with is that it is reasonably correct, more nearly correct than any other unit we can, at this time, adopt, that it is possible of application, and then we should decide that it shall be our *standard of measurement*.

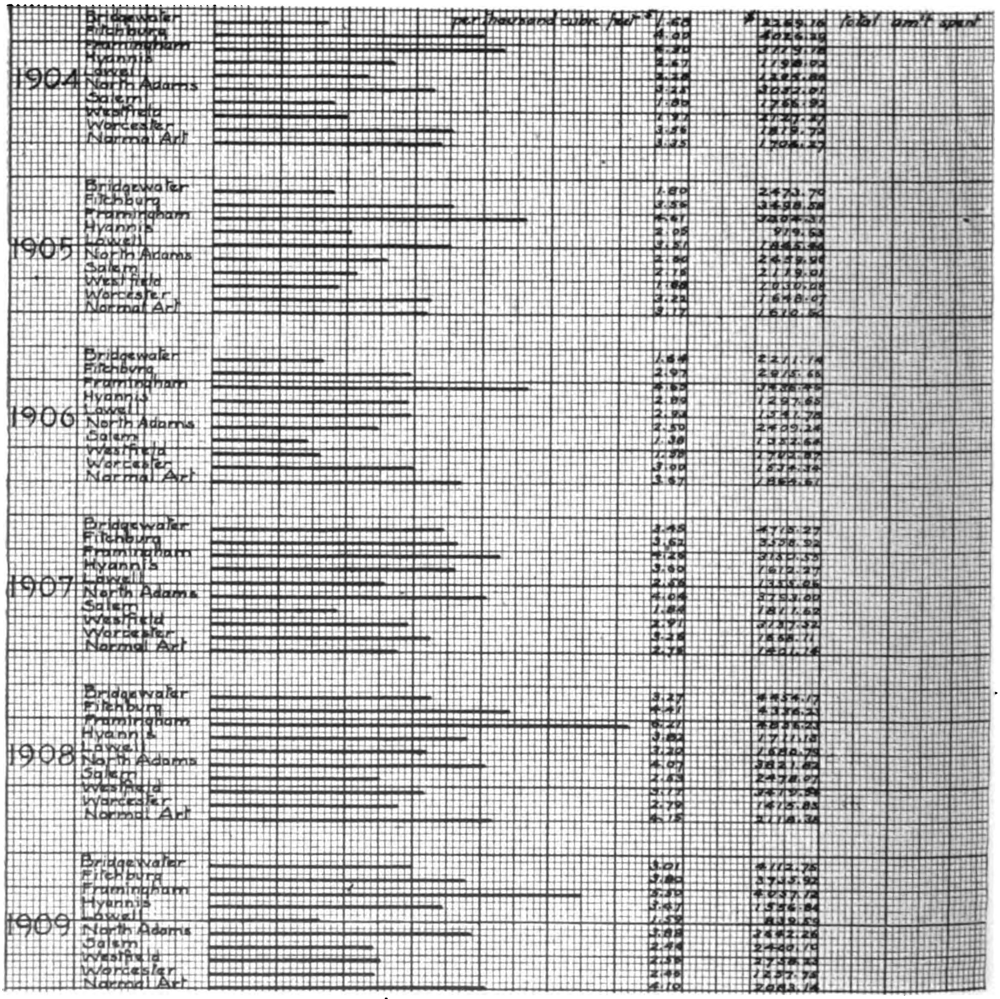


CHART SHOWING THE AMOUNTS EXPENDED BY THE MASSACHUSETTS NORMAL SCHOOLS FOR HEAT, LIGHT AND POWER FROM 1904 TO 1909, FIGURED PER THOUSAND CUBIC FEET.

To the use of cubic contents, as defined above, some objections may be offered, and these objections may have some reasonable basis, yet I shall attempt to show that the cubical contents of the building will give a more certain basis for an accurate estimate of the size of a building than any other, and it will certainly be superior to the haphazard, "go-as-you-please," "everyone-for-himself" method of determining cubage used at present.

The cubic contents of the building has additional interest to us as school officers. With it we may not only estimate the cost of a building, but also the cost of repairs, the cost of heating, of lighting and of cleaning the building. These are subjects with which the architect and engineer have little to do, but they are important matters to consider.

To illustrate the value of the adoption of this standard, cubic contents, I have incorporated in this paper diagrams showing the application of this principle to the cost of repairs, improvements, heat, light, power and furnishings in ten of the normal schools of Massachusetts.

The first, shown herewith, is a diagram showing the amounts expended by normal schools in Massachusetts for heat, light and power from 1904 to 1913.

In columns on each of these diagrams are shown the cost per thousand cubic feet and the total amount expended. To illustrate these figures I have drawn lines in exact proportion to the cost and showing the relation of one to the other.

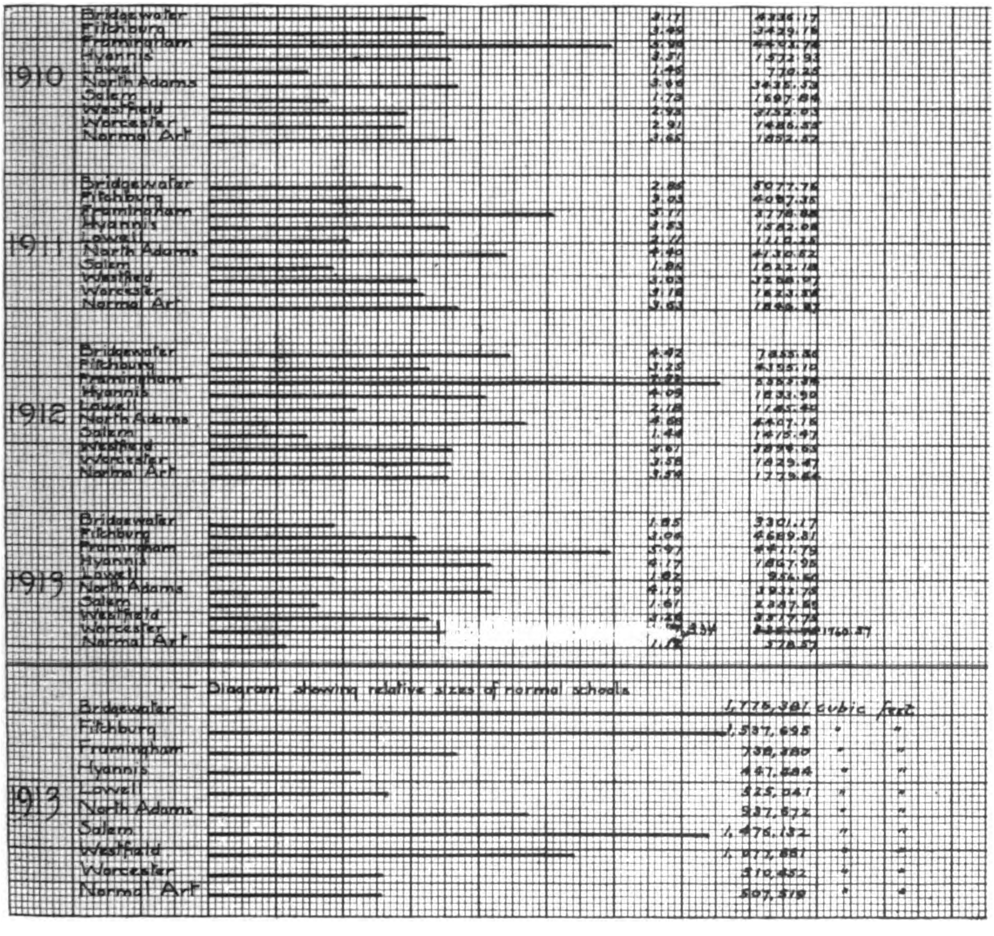


CHART SHOWING THE AMOUNTS EXPENDED BY THE MASSACHUSETTS NORMAL SCHOOLS FOR HEAT, LIGHT AND POWER FOR 1910 TO 1913, FIGURED PER THOUSAND CUBIC FEET.

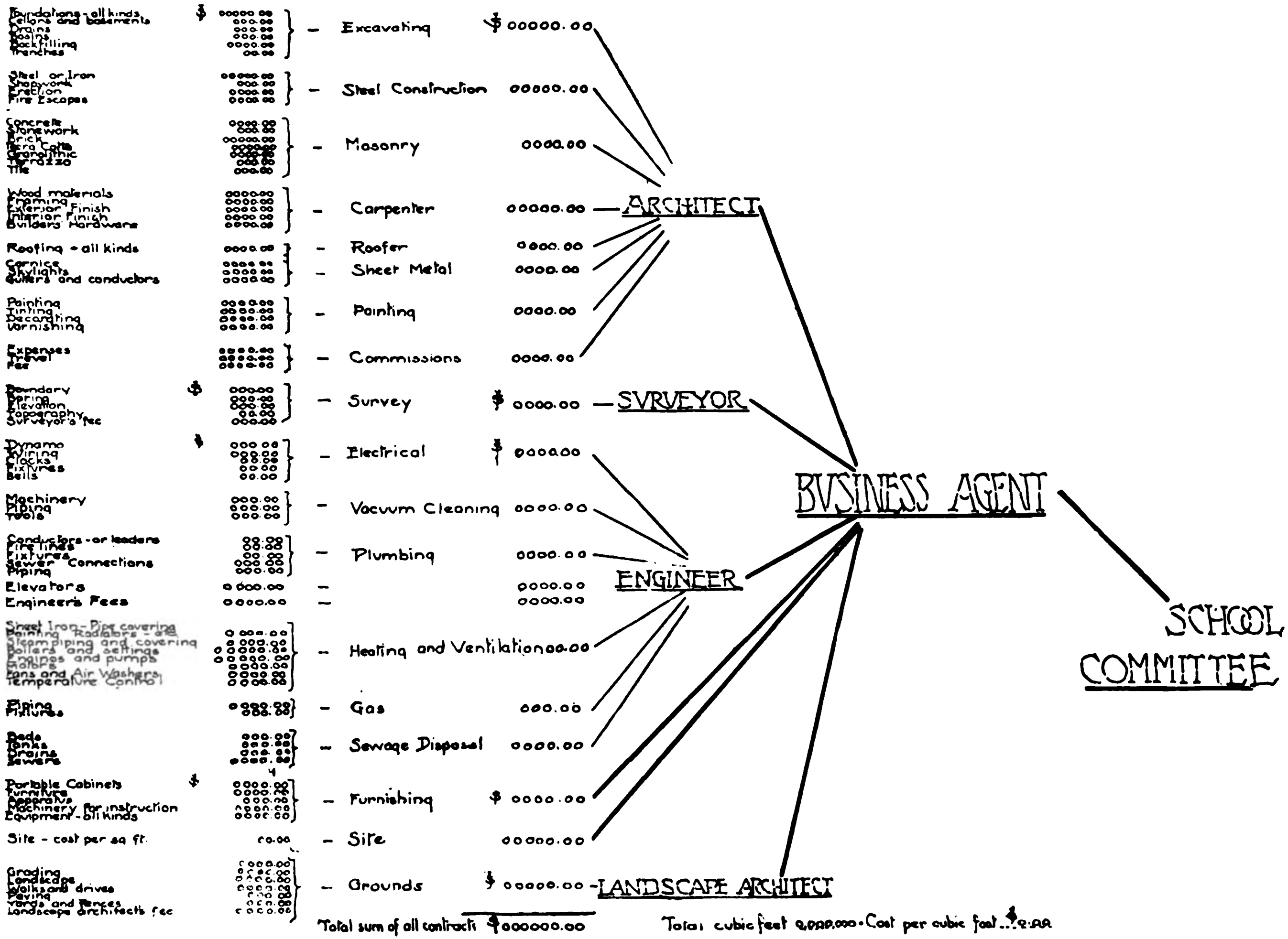


DIAGRAM OF COST AND ORGANIZATION OF THE WORK INVOLVED IN THE CONSTRUCTION OF A SCHOOLHOUSE IN MASSACHUSETTS.

(Drawn in the office of the Massachusetts Board of Education, May, 1915.)

A study of these diagrams shows a radical difference in the costs for the several schools. Not only does it show the difference in the cost of each school in relation to the other schools, but it shows the increase or decrease in the cost of each school from year to year.

I think that you will agree that a study of these diagrams is most interesting and enlightening to the board having control of such institutions.

It will be seen that when considering, for example, the subject of heat, light and power, the effect of different types of heating apparatus, difference in equipment, differences in effectiveness of employes, and in the kind of fuel used, are very clearly shown. With diagrams of this kind accurate estimates can be made and those in authority have something definite and reliable upon which to base their reasons for action.

The application of this standard in this practical way to the normal schools of Massachusetts is a very good indication of what may be found by its application to other schools in other states or cities of the country.

ITEMS INCLUDED IN THE COST OF BUILDING.

Having determined the unit upon which the cost of construction should be based, it is equally important to determine what items of expense should be included in the cost of a building.

Perhaps it has come within the experience of each one of you that the final cost of a building has overrun the estimate because of the omission of very important details. It is imperative, therefore, that every detail should be included in the total cost before this cost is divided by the cubic contents of the building to get the cost per cubic foot. To illustrate, I will call your attention to another diagram.

COST PER CLASSROOM.

It may be suggested that the cost per classroom is a better unit than that suggested here. It would, perhaps, be better if there were any uniformity as to our buildings, but there is none. The cost per classroom in a building containing twelve classrooms only, may be one sum, but the cost of a twelve-room building with assembly hall, manual training room, cooking room and sewing room, will be entirely different. It must be evident that no comparison can be made between two such buildings on the basis of cost per classroom, or per pupil, notwithstanding the fact that both buildings might accommodate the same number of pupils.

There is no objection to adding to our plan information showing the number of pupils and the cubic contents per pupil, in fact, I believe that is a highly desirable thing to do. By so doing a comparison between types of buildings could easily be made. For example, one building may show that the cost is fifteen cents per cubic foot, and the number of cubic feet per pupil is 18,000, while the cost of another building is fifteen cents per cubic foot and the number of cubic feet per pupil is 30,000. If these figures were exact they would show that one architect, or school board, had been more economical with space than the other, or that in order to reduce the total cost of the building one architect, or school board, had greatly restricted the space per pupil.

It may be possible that in the future standard specifications will be agreed upon calling for a definite number of cubic feet per pupil for each type of building, and a direct comparison of the cost per cubic foot can then be made very readily.

By the adoption of the standard I have outlined above, this desirable end may be readily accomplished, and all discussions that arise as to the cost of the whole, or any part, of the building can be compared.

SUMMARY.

The adoption of the plan suggested involves the following:

1. Classifying buildings by types according to their use.
2. Rating them in accordance with their construction.
3. Computing the actual cubic contents of all usable space.
4. Dividing the total cost by the cubic contents to determine the cost per cubic foot.
5. Dividing the total cubic contents by the number of pupils to determine the cubic feet per pupil.

District Heating

By S. Morgan Bushnell and Fred B. Orr.

Heating and Power Costs.

(*This series of articles commenced in the January, 1915, issue.*)

The costs to be included for isolated plant operation are:

1. Annual fixed charges which are based on the cost of the boilers, engines, dynamos, piping, furnaces and building space required for the installation of the plant.

2. Operating costs which include the items necessary for the operation of the plant after it is installed.

Under fixed charges, we have:

(*a*) Amortization, which means the amount of money which needs to be set aside each year in order to replace the plant at the expiration of its usefulness. This is usually figured at about 3% of the first investment.

(*b*) Obsolescence, which is a term used to express the loss in value due to change of conditions. The more important of these changes are changes in the business itself, requiring different types or sizes of apparatus than that originally installed. 2. Improvement in the types of apparatus manufactured, thereby making old apparatus obsolete and unsatisfactory. 3. Reduction of rates by the central-station companies, making the investment unprofitable long before the machinery is worn out. The item of obsolescence is variously estimated, but an average estimate would be about 5%.

(*c*) Interest. Interest rates vary from time to time, but considering the risk of a plant installation, 6% may be considered as a fair rate of interest.

(*d*) Repairs. The item of repairs is often included in operating costs, but as it varies so much from year to year and is usually higher as the plant grows older, in order to get an average cost of repairs it is simpler to take a fixed percentage of the cost of the plant as the average cost of repairs, and this is usually placed at 2%.

(*e*) Taxes. Taxes vary in different localities. In cities like Chicago, the item of taxes runs from one to one and one-half per cent., but an average would probably be one per cent.

(*f*) Another fixed charge which can be estimated in two ways is the rental value of space. 1, as the value which could be secured by renting the space to the tenant, or 2, it can be figured on the basis of the interest and depreciation on the building investment necessary for taking care of the isolated plant. Often in large cities where space is valuable, very expensive excavations are made in order to provide space for the independent plant. If the annual fixed charges on these excavations is added to the operating cost, it is found that the plant has been an expensive luxury.

(*g*) To the above charges should be added what is sometimes called "the marginal cost" of operating a plant. This cost is estimated on the following basis:

Almost every large business is limited by its ability to secure capital to carry on the business. If a business is a profitable one, there is usually a considerable margin over the actual cost of borrowing money—perhaps 15% would be the average turnover on the money invested in a private business. If money is used in the installation of a private plant, it means so much capital deducted from the business itself, or else it means a straining of the credit of the organization. It is very frequently found that owners will invest large sums of money in private plants only to find that they have made unprofitable investments and at the same time have taken money from their business which is very much needed. While it might not be fair to charge the entire difference between the cost of money and the average annual profit, yet the marginal charge is without doubt a reasonable one and an average estimate might be placed at 5%.

The operating in connection with a private plant may be sub-divided into two main divisions, viz., salaries and supplies.

Salaries include wages paid to engi-

neers, boiler-washers, plumbers, steam-fitters, electricians, oilers, firemen, coal-passers, engineer's clerk and such office help as is required for looking after the operation of the plant. The time of the manager of the organization or owner which would be taken up in the supervision of a power-plant organization should also be included.

Supplies include coal, transportation of ashes, oil, waste, water, shovels, fire-tools, electricity for light, power and ventilation, and handling of coal in boiler and engine-rooms, lamps, carbons, miscellaneous supplies.

These items may be given in tabulated form as follows:

1. *Fixed charges based on investment in*

Building,
Boilers,
Piping,
Dynamos,
Furnaces,
Engines,

and various accessories for the above.

(*a*) Amortization.
(*b*) Obsolescence.
(*c*) Interest.
(*d*) Repairs.
(*e*) Taxes.
(*f*) Rental value of space.
(*g*) Marginal charge for diversion of capital.

2. *Operating Costs.*

Salaries.
- Chief Engineer.
- Assistant Engineers.
- Firemen.
- Coal-Passers.
- Oilers.
- Electricians.
- Steam-fitters.
- Boiler-washers.
- Elevator repair men.
- Helpers.
- Engineer's clerk.
- Office labor for metering and billing.
- Employer's liability insurance and salaries paid to injured employees when off duty.

Also a portion of the time of the management used in buying supplies and looking after the operating organization.

Supplies.
- Fuel.
- Transportation of ashes.
- Oil, waste, water.
- Shovels, fire-tools.
- Electricity for lighting and power in boiler-room.
- Boiler and fire insurance.
- Miscellaneous supplies and expenses.

All of the above are direct costs which are directly chargeable to the cost of operating a plant. In addition to the above costs, there are other costs which might be termed indirect charges which often come as a result of power-plant operation.

1. Throw over switch service from central-station service. As a rule the cost per K.W. hour for throw-over switch service is greater than the rate where complete service is furnished, and often a minimum bill is required in addition to the higher rate.

2. Danger of breakdown in the service and consequent loss if throw-over switch is not installed.

3. Losses on account of decreased rental value of the building. The majority of isolated plants operated with high-speed engines, shows a marked fluctuating quality in the light. This is usually increased at irregular intervals where high-speed electric elevators are operating on the same plant. It is also frequently found that in the summertime the space directly above the boiler is hard to rent on account of the heat coming up through the floor from the engine-room below. There is also the damage and annoyance caused by vibration in the building.

4. Losses of time on account of obstruction of entrances by coal teams. Some of the firms which have discontinued the use of their own plants and gone on central station service have been particularly desirous of getting the steam service also in order that they might discontinue the delivery of coal to their buildings, and thereby be able to receive and deliver goods without any interference with coal teams.

5. Losses on account of smoke fines, or dirt in the building, due to operation of the boilers. In large western cities where soft coal is used, there has been an active campaign started to prevent the emission of smoke, and a number of these cities have laws imposing fines on the owners of smoky chimneys.

6. Losses on account of strikes, due to labor troubles.

If the above costs of operation are carefully tabulated and are based not on the theoretical economy of apparatus when operating at maximum load when new and under special conditions, but on the average operating economy as found in plants around town, they will show a substantial saving by the use of central station service providing the rates for central station service correspond with those recently made in many of our large cities. However, it is often easy to prepare figures which may appear theoretically correct, which give an entirely different result and perhaps show a saving by the use of an isolated plant. These figures fail to take account of the fact that where human agencies are employed there are always some mistakes being made and more or less waste from one cause or another.

Very few isolated plants can afford to purchase a high quality of talent in the operation of their machinery, and the result is that many things are continually going on in the engine room which militate to a great extent against economy of operation. The moment a plant is installed, no matter how well it is equipped, is the moment it starts to decay. If it is constantly oiled and kept in operation, it may appear to wear out, but there are various chemical causes of deterioration which are constantly at work, as, for example, oxygen forming rust, formation of scale by various deposits, and various changes in the substance of which the apparatus is made.

In other words, no matter how carefully a plant is installed, it is only a few months before a great many things require attention and repair. It is not profitable to keep up a plant to the high efficiency which it has when new. The plant owner would spend most of his time in making replacements.

In figuring the average cost of operating the plant, there are always losses to be figured, based on the average efficiency of a partially worn-out apparatus. The ordinary engineer in making up figures is apt to figure his coal on the theoretical B.T.U. contained in a pound of coal and he forgets the losses which come through poor coal occasionally delivered by coal companies, the loss caused by excessive moisture during rainy days in the winter time, and other losses caused by frozen coal. All these contingencies must be met from day to day in the operation of every power plant and these combined losses have a very important bearing on the general result at the end of the year.

In taking up the argument of central station versus isolated plant, the salesman should prepare himself especially on all the various factors, which enter into the heating problem. The engineer of a plant will always come back to his first plea, viz., "using exhaust steam for heating." In other words, he will claim that either the heat is secured for nothing or the electric lighting and power is secured for nothing in the winter time, due to the fact that he is using exhaust steam from his engines in heating the building.

HEATING BY EXHAUST STEAM.

Let us look a little more closely into the subject of heating by exhaust steam. It is not in all respects as satisfactory as has been represented. One of the first disadvantages met with is that oil is distributed all through the heating system, wherever exhaust from the engines has been used for a long time. To be sure oil separators can be used which will diminish this to a certain extent, but in nearly every combined heating and power plant there is found not only oil in the general heating system, but also the returns come back to the boilers with more or less oil, causing trouble in the boilers themselves. This, of course, occurs only where the steam passes first through an elevator pump or steam engine and the cylinder oil becomes mixed with the steam and circulates through the system. Where the boiler plant is operated for steam heating only, there is, of course, no occasion to use oil and the system remains intact.

Another disadvantage of the power plant as compared with the straight heating boiler is the high pressure it is necessary to carry in the boiler. It is not necessary to explain to any one that the higher the pressure in the boiler, the more danger there is of explosions and the various troubles to which boilers are subjected. The ordinary heating systems are usually operated at a moderate pressure with reducing valves at the various buildings to adjust the pressure to their requirements. Another disadvantage in the use of a power plant as opposed to the ordinary heating system is the excessive heat on the first floors and basement during the summer time. In the ordinary large building where steam is only required for heating and hot water service, it is simply necessary to operate a small water heater by means of hard coal or coke during the summer time. This requires about the same attention as the ordinary furnace in a private house.

An isolated plant requires boilers operated at high pressure all summer long, resulting in intense heat in the basement, which usually communicates itself to the offices and stores on the first floor. An advantage of central station heating service is the reliability on account of the large source of supply. Many buildings have simply a single small boiler to supply them with heat and if anything happens to this boiler, they are in trouble. When steam is sold on the meter basis, the consumer can turn the steam on and off as he needs it and pay for only what he uses. There is therefore a great tendency to eliminate waste of steam, whereas in many office buildings, operating a power plant of their own, steam is kept turned on whether it is needed or not and often when it is injurious to the occupants of the building.

In order to illustrate the method of analyzing the comparative costs of operation in a large city office building, the following are figures on a building recently analyzed in the city of Chicago. This building is a large office building about 200 ft. square and 21 stories in height.

It has a court in the center above the first floor 73 ft. square. The original estimate of the steam consumption based on the formulæ given in this book was 63,200,000 lbs. of steam. The actual consumption during the year 1913 as shown by meters was in round numbers 64,300,000, or about 1,100,000 lbs. over the estimate.

As the steam consumption in any building will vary ordinarily a much larger percentage from season to season, the estimate given may be considered fairly accurate. The original estimate for consumption of electricity was 1,250,000 K.W. hours. The consumption in 1913 was 1,100,000 K.W. hours. If a plant had been installed in the building, the consumption would probably have been about 50,000 K.W. hours more, and as the building is not quite rented, a complete rental of the building would probably bring the current consumption very nearly up to the estimate.

The actual consumption for this building was, in round numbers, 500,000 K.W. hours for tenants lighting, 150,000 K.W. hours for public lighting, and 450,000 K.W. hours for power, of which about three-quarters was consumed by the elevator equipment. Assuming a price for electricity of 2½c. per K.W. hour, from the central station service and a price of 40c. per thousand pounds for steam on central station service, it is very easy to figure the cost of central station service on this basis. Let us assume that the building will be fully rented and that the total consumption is 1,150,000 K.W. hours. We will also assume that the building purchases its entire requirements both for steam and electricity and retails the electricity to its own tenants. The total bills for the building would be:

1,150,000 K.W. hours at 2½c. per K.W. hour	$28,750.00
64,300,000 lbs. of steam at 40c. per thousand lbs.	25,720.00
Total	$54,470.00

In figuring the cost of isolated plant service, it will be necessary to add the cost of electricity for lights in engine and boiler rooms, and also the cost of ventilating same. Assuming, therefore, that this amounts to 50,000 K.W. hours per year, the total electricity used by the plant would be 1,150,000 K.W. hours plus 50,000 K.W. hours, or 1,200,000 K.W. hours per year. The average steam consumption in office building plants as

shown by a number of tests taken on typical installations is about 60 lbs. of steam per K.W. hour throughout the year. While the above would represent average conditions, in this comparison it would be better to assume 50 lbs., since in a large building such as this it would be possible to get an economy above the average.

1,200,000 K.W. hours of electricity at 50 lbs. per K.W. hour would require 60,000,000 lbs. of steam per year. From the discussion and curves in the preceding chapter it would be fair to assume that about 40% of this would be saved for heating by utilizing the exhaust from the engines. This would leave a net steam consumption of 60% of 60,000,000, or 36,000,000 lbs. It has been shown by meter readings that the heating requirements of the buildings are 64,300,000 lbs. of steam. Adding together the steam required for electricity and the steam for heating, gives a total of 100,300,000 lbs., or in round numbers 100,000,000 lbs. of steam per annum. The average evaporation in this plant runs about 5 lbs. of steam per pound of coal. If a power plant were operated all summer long the average evaporation would be somewhat higher, say 5½ lbs. of steam per pound of coal. On the basis of 100,000,000 lbs. of steam, the annual coal consumption would be 18,181,818 lbs., or in round figures 9,000 tons. On this basis the operating expenses would be as follows:

Supplies.

9,000 tons of coal at $2.75 per ton	$24,750
Ash removal—6%	1,485
Water—for steam supply, washing out boiler and engine-room, etc.	1,000
Oil, waste and packing	1,200
Tools and miscellaneous supplies	1,200
Boiler and fire insurance	60
Total	$29,695

Labor.

Chief engineer	$3,000	
Assistant to chief engineer	1,500	
3 watch engineers	3,600	
2 oilers	1,920	
Engineer's clerk	480	
3 firemen at $840	2,520	
2 ashmen at $720	1,440	
Liability insurance and losses from sickness among employees	1,000	
Time of office, including manager's time for supervising	1,000	
		$16,460
Total operating expenses		$46,155

In addition to the operating costs we must include the:

Fixed Charges.—To take care of this building, which has an aggregate installation of about 15,000 50-watt lamps, 200 H.P. in general power, and 600 H.P. in elevator power, or a total connected equipment of about 1,800 H.P., it will be necessary to install a plant of about 1,200 K.W., which would cost complete at $50 per K.W., about $60,000. The plant would also require space of upwards of 6,000 sq. ft. On the above basis, the fixed charges would be as follows:

Amortization at 3%	$1,800
Obsolescence at 5%	3,000
Interest at 6%	3,600
Repairs at 2%	1,200
Taxes at 1%	600
Rental value of space at 50c. per sq. ft.	3,000
Marginal charge for diversion of capital at 5%	3,000
Total	$16,200

Summarizing the above, we have:

Operating charges	$46,155
Fixed charges	16,200
Total	$62,355

It will be noted that the cost for labor to take care of the elevators, electric fans, etc., as well as the radiation, has been omitted from both estimates, as they are practically equal in both propositions Comparing this with the above cost of central station operation, we find a saving of about $8,000 per year. As a matter of fact, the central station costs in Chicago are slightly under these figures. If the price for electricity, however, were 4c. per K.W. hour and the price of steam 50c. per thousand pounds, the situation would be reversed, and there would be a saving of about $16,000 in the operation of an isolated plant. In other words, the result is not determined by the cost of isolated plant operation, but by the rates offered by the central station company.

The above figures are given as average figures and may be found to be higher or lower in different localities and in different plants. The fact that some of the largest buildings in Chicago now operating plants are running at considerably higher expense than that assumed in this estimate tends to show that the estimated

cost of isolated plant service is conservative.

The above example is given merely as a guide to show the method of analyzing a given proposition and as an illustration of how accurately the consumption of a modern building can often be foretold by a careful study of the conditions beforehand. The estimates on consumption of electricity were checked at the time they were made by a comparison with the results in similar buildings. The estimates on steam consumption were based on the information given in the preceding articles. Inasmuch as any estimate of operation would be incomplete without including the cost of the heating service, it is impossible to make an intelligent study and analysis of the requirements of large buildings without thorough investigation and experience in the costs of heating these buildings.

The Difficulty of Measuring Heat

WITH SPECIAL REFERENCE TO RADIATED AND CONVECTED HEAT.

BY A. H. BARKER, B. SC. AND F. C. S. BRENDAL, B. SC.

(*From a lecture delivered at University College, London.*)

II

The essential principle of the thermopile is that when two conductors made of different metals are soldered together at their two ends and when those two ends are maintained at different temperatures, an electric current (which is very easy to measure exactly) will pass round the circuit whose magnitude is proportional for small differences of temperature to that difference. In order to multiply the effect, a number of these contacts are built up into a single fitting so that all the positive contacts face in the same direction. The surface formed by these contacts is exposed to the radiation whose intensity it is desired to measure, the other or negative contacts being not so exposed. The exposed surface thus absorbs the radiation which raises its temperature.

The current generated by the difference of temperature on the two sides of the thermopile is passed through a delicate galvonometer and is thus measured. The magnitude of the deflection in the galvonometer thus gives a measure of the intensity of the radiation.

It will be evident at once that this is a very indirect method of measuring radiation. How are we to know what the temperature effect of a given intensity of radiation on the thermopile will be? Primarily the current produced by the thermopile is merely a measure of the then existing difference of temperature between its two ends, and the law connecting the intensity of the radiation and the current given by the galvonometer is very difficult to determine. The difficulties may be briefly alluded to as follows:

Let us assume that the receiving surface of the thermopile is such that it converts the whole of the net radiation falling on it from the source into heat, i. e., that none is reflected. It is not by any means certain that it does so in fact. The effect of this heat communicated to the face of the thermopile is to raise its temperature. It is evident that some of the heat will be conducted away along the metal conductors of which the thermopile is composed to the back end. It would be a matter of practical impossibility to calculate what would be the rate of that flow of heat. Further, the ends of the thermopile in addition to being warmed by the radiant source are either warmed or cooled by contact with the surrounding air, more or less according as the ends are protected.

The question arises, does the difference in the temperature of the surrounding air make any difference to the reading of the thermopile, and if so, what dif-

ference? On the one hand every such difference would re-act similarly on the two sides of the thermopile if they were at the same temperature, but they are not.

If both ends of the thermopile are slightly cooler than the air, it is clear that the tendency of the contact of warm air will be to communicate more heat to the cooler end of the thermopile than to the warmer, and therefore to diminish the difference of temperature between the two ends, and so reduce the reading. If the thermopile is warmer than the air, the loss of heat will be greater from the warmer surface, which again tends to reduce the difference.

At first sight, therefore, one might suppose that a difference in the air temperature in the room would make little difference in the reading. In the experiments, however, we fear that a difference of room temperature does in fact make a difference in the reading.

On the other hand the thermopile can be, and is protected to a large extent from the effect of air currents by being totally enclosed, so far as is possible, and the amount of heat which is likely to be communicated to each face cannot be calculated.

RESULTS AFTER CALIBRATING THE INSTRUMENT.

It is evident that in order to obtain an accurate result, it is necessary to calibrate the thermopile experimentally throughout its whole range with the readings of the absolute instrument or radiometer and at different air temperature. We have made this comparison, though not so exhaustively as we intend to, and find that for this instrument and under the conditions in which we are working at a constant room temperature, the quantity of radiation is proportional to the 1.4th power of the current in the instrument. This, therefore, gives us the means of converting the galvanometer readings into B. T. U. per square foot by means of a series of factors differing according to the reading of the galvanometer and of the room temperature.

In previous experiments on this point the assumption has been tacitly made that the intensity of radiation is proportional merely to the reading of the galvanometer. This assumption is incorrect and must vitiate to a large extent previous results which have proceeded on this assumption.

It is possible that a more accurate method might be to maintain the cold junction at a constant temperature by enclosing it in a receptacle surrounded by melting ice or some other well-known method of maintaining a constant temperature. This would, however, involve that the air in the room should be kept constant in temperature, which is not an easy condition to carry out, especially when the whole of the result depends on the accuracy with which it is done. On the whole, from our experience we find it is better to take the reading without any artificial cooling of the negative junction.

It will be noted that it might be possible to obtain the convected energy in the case of an electrical radiator, especially by a process of subtraction. We know that the whole of the energy supplied is dissipated either by radiation or by convection currents. We know positively and accurately the total quantity of energy supplied to the apparatus. If then we measure with some approach to accuracy the total quantity of energy radiated, the difference between these two might be taken to be the quantity of convected energy. This, however, is an unsatisfactory method of going to work. It is much more convincing to measure positively the two quantities which go to make up the total and compare their sum with the measured total. A result of this kind gives us much more confidence in the accuracy of the results than the other method. This is a sort of bookkeeping by double entry as against single entry.

EVEN GREATER DIFFICULTIES PRESENTED BY STEAM AND HOT WATER RADIATORS.

Mr. Barker went on to indicate how much more difficult were the problems presented by hot water or steam radiators and coal fires, which would form the subjects of future lectures.

An Organization to Classify Technical Literature.

Delegates from about twenty national technical and scientific societies met in the United Engineering Societies Building, New York, May 21, to perfect a permanent organization with the object of preparing a classification of the literature of applied science which might be generally accepted and adopted by such organizations. W. P. Cutter, librarian of the Engineering Societies Library and a delegate from the American Institute of Mining Engineers, read a paper on "The Classification of Applied Science," in which he outlined a plan whereby a central office could collate all the existing classifications and, with the help of specialists in the various national societies interested, compile a general system.

Permanent organization was effected by the election of the following officers: Chairman, Fred R. Low; secretary, W. P. Cutter. Executive Committee: Fred R. Low, W. P. Cutter, Edgar Marburg, H. W. Peck and Samuel Sheldon. It was agreed that a special invitation be sent to other national societies to participate by the appointment of delegates. The American Society of Heating and Ventilating Engineers was represented at the organization meeting by J. J. Blackmore.

Efforts will be made by the executive committee to enlarge the membership of the committee to include delegates from all similar national organizations and to prepare a plan for further action.

The name adopted for this organization is "Joint Committee on Classification of Technical Literature," and the temporary address of the secretary, W. P. Cutter, is 29 West 39th Street, New York.

Organization of New Industrial Board in New York State.

The new Industrial Commission, which was provided for in recently enacted legislation in New York State, to take over the work of the Workmen's Compensation Commission and that of the Commissioner of Labor, has been organized by Governor Whitman with the following members:

John Mitchell, chairman; James M. Lynch, formerly State Labor Commissioner; Louis Ward of Batavia; William H. H. Rogers, of Rochester, and Edward P. Lyon, of Brooklyn. Each of the commissioners will receive a salary of $8,000.

As announced last month, the new Industrial Commission does away with the industrial board of the Labor Department, which has had the power of making rulings regarding the heating and ventilation of factory buildings.

Architects Must Be Licensed in Illinois.

The Illinois law requiring architects practicing in that state to be licensed has been in effect 17 years, but few attempts have been made to enforce its provisions rigidly until the present board of examiners took office. The legality of the act has been established recently by the Supreme Court of Illinois and the board now proposes to enforce the provisions on its broad interpretation.

In the report of Francis M. Barton, secretary of the Board of Examiners of Architects of the State of Illinois, it is stated that there are at present 863 licensed architects, 410 architects who were admitted because they were practising when the law went into effect and 453 architects who passed examination by the board. While the board has agreed upon a broad interpretation of the wording of the law, it holds that only a licensed architect can practice in Illinois, or from the state, and that his license is not transferable or negotiable. There has been no Supreme Court decision on the matter until the present board assumed office and practically no court action of any importance that would give the board a precedent to follow.

The report states further that "this board has found its greatest work to be the elimination from the architectural field of various architectural firms which operate under an alias, such as architectural engineers, civil engineers, industrial engineers, designers, builders, etc. Most of these violations are assisted by a licensed architect who is either financially interested, a partner, or who secures a salary. The board has eliminated at least twenty such illegal combinations in the last few months and expects to eliminate all others from the architectural field in the near future. These combinations are to a great extent the result of lack of enforcement of the law or improper interpretations of the meaning of the wording of the act.

"Attention is called to the fact that all structural engineering on buildings is part of the architect's work and cannot be performed by others, except under the direction of a licensed architect; and that the architect is responsible for all engineering data on his sealed plans, whether performed by him or not."

The decision of the Supreme Court, which is referred to, was to the effect that the act is constitutional.

The next examination, it is announced, for the licensing of architects, will be held October 20, 21 and 22, 1915, at the University of Illinois, in Urbana.

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WITH the constantly increasing fund of technical matter that is being placed at the disposal of engineers, it is rapidly becoming a serious problem as to how this matter shall be made easily available for reference purposes. The problem applies not only to those who have had the opportunity of acquiring the data at the time of their publication, but also to the newcomers in the engineering field who find themselves almost literally swamped in a sea of technical literature which must be fairly bewildering to them. The fact is that only the few take the pains to collate the matter that directly applies to their line and, even then, they must of necessity at times overlook important contributions. Of course, indexing systems of various kinds have been proposed, many of which are now in use, but the difficulty is that they all lack, more or less, the feature of comprehensiveness.

It is evidently a realization of this condition that has prompted the movement, as noted on another page of this issue, to prepare a classification of the literature of applied science which could be generally accepted and adopted by the engineering world. It is stated that some twenty national technical and scientific societies were represented at the organization meeting for the furtherance of the plan and that the consensus of opinion was to the effect that such a classification, if properly prepared, might well serve as a basis for the filing of clippings, for cards in a card index and for printed indexes. It was further proposed that the publishers of technical periodicals might be induced to print against each important article the symbol of the appropriate class in this system. By clipping such articles a file could be made that would combine in one system these clippings, together with trade catalogues, maps, drawings, blue prints, photographs, pamphlets and letters, classified by the same system.

It is easy to see how such a system might in itself become cumbersome, but that is a separate problem that can be met by each profession for itself. The crying need just now is for the central index.

FOLLOWING are some of the ideas thrown out at the recent convention of the district heating engineers:

Boiler room efficiency can be increased in practically every power plant.

Powdered coal is the coming fuel.

Central station heating is the greatest undeveloped monopoly in this country.

Greater efficiency will place every unprofitable district heating plant on a paying basis.

Four fairly full-sized thoughts for one convention.

NATIONAL DISTRICT HEATING ASSOCIATION

Seventh Annual Convention, Chicago, June 1-3, 1915

From the standpoints of attendance, enthusiasm, character of the papers and reports presented, and outlook for the future, the seventh annual convention of the National District Heating Association, in Chicago, June 1-3, 1915, was a notable milestone in the growth of the central station heating industry.

A statement that possibly 50% of the companies supplying central station heat, if asked, would say that they were not making a profit, quickly brought forth the rejoiner that if this were true, it would only apply to those selling heat on a flat rate basis and that few meter rate companies could be found that were not making a success of the business. Incidentally it was brought out that about 80% of the district heating companies were still doing business on a flat rate, although the meter rate basis is now generally recognized as the only method, as far as steam heating service is concerned, that can be expected to give satisfactory results to both the company and the consumer.

D. S. BOYDEN, BOSTON, MASS.
President, National District Heating Association.

One speaker went even further and declared that if the companies showing no profit on the heating end of their business would submit their operating data to a competent committee, he felt assured that the leaks could be stopped and the business made profitable. He even went so far as to suggest the appointment of a "consulting staff" committee to take up these very matters. Since the companies are now obliged to make detailed reports to the public service commissions, the element of secrecy in plant operation would not be involved.

Enthusiastic applause greeted his statement that central station heating is today the greatest and most promising undeveloped monopoly in the country.

With a registration of 258 members and guests the prospect of a successful convention was assured at the outset. Among the most important matters that came up for discussion were the reports of the station operating committee and of the educational committee, which are summarized in another column.

Two of the keynotes of the convention were struck when a speaker declared that the crying need of power plants today is greater efficiency in the boiler room, and that the use of powdered coal for fuel is shortly to become standard practice.

A special word should be said regarding the exhibit hall, which contained one of the most attractive displays of district heating apparatus and appliances shown

at any convention. The fact that passage to the meeting room was through the exhibition hall was a happy arrangement that contributed much to the success of the convention.

First Session, Tuesday Morning.

The opening session was called to order by President H. R. Wetherell at the Hotel Sherman. Harry Muller, prosecuting attorney of Chicago, welcomed the delegates to Chicago on behalf of Mayor Thompson. His address of welcome was acknowledged by David S. Boyden. President H. R. Wetherell then presented his address:

PRESIDENT'S ADDRESS.

"No doubt, if you were to make a canvass of all the heating companies in operation at the present time as to whether they were operating on a paying basis, 50% of them would tell you that they were not. If you were to ask these companies how many feet of mains and services they had installed, how much steam they sent out per square foot of radiation connected, what their line loss amounted to per square foot of surface in mains and services, and how much revenue they were receiving per square foot of radiation and per 1,000 lbs. of condensation, they probably could not tell you. You would also find that there was no one person in direct charge of the heating department or that the electric or gas superintendent or some other official, whose time was all taken up looking after his own department, was taking care of the steam department as a side issue.

"Gentlemen, I believe the day has come when we should not look on the steam heating as a by-product of the electric, which should be given away at cost or at a loss to secure the electric business. I believe that with the use of the modern heating systems and the proper attention and engineering that steam can be sold by meter rate at a cost which will be attractive to the customer and also pay a good revenue to the heating company.

"The coming of the public service commission is also a good thing for the district heating company. The ruling of the public service commission requires the district heating company to sell steam for their published rates only, which eliminates the old practice of making special rates and giving steam service at a very low cost in order to secure the electric business. Contracts of this sort are a great many times the cause for the heating department being operated at a loss.

"If you were to make an investigation of all of the companies who are losing money on their heating departments you would find in 90% of these companies that it was not the cost of the operation that was excessive, but that they were not receiving enough revenue for the service they were delivering. If you were to place several meters on some of the heating systems which were operating under a flat rate you would find that they were using from two to three times as much steam as they were paying for, basing the charge for the metered steam at a rate which would pay you a fair profit above your operating expense.

"If you were to put these same customers on a meter rate and teach them how to regulate their service they would cut their consumption to the point where their season's charge would be as low, if not lower, than they had paid you under the flat rate system and you would be making money on this service. You would also have the amount of steam that they had originally wasted to sell to some other customers, which it was impossible to connect to your lines with the old arrangement for lack of capacity.

"The day has also come when the public service company should co-operate with the customer and break away from the old method of keeping the customer in the dark. By this I mean that we should not hesitate to show them our records and let them know what the other fellow is paying. We should also show the customer every possible means of regulation in order that he may cut his bill to the minimum. If you are operating under a sliding scale of rates, the lower the customer's consumption the company will receive a higher rate per 1,000 lbs. of steam. This is particularly true when you are operating under a guaranteed maximum charge.

"I know of several companies who read their steam meters four times a month and the pounds of steam consumed per square foot of radiation connected in each building is computed. If it is found that the customer is using more steam than he should for his particular class of business a man is sent out by the heating company to inspect the meter and to take morning and evening readings each day for several days to see if the customer is shutting his service valve at night and to find just what regulation the customer is giving to his heating system. When this information is secured a postal card is sent to the customer showing the reading of the meter for the beginning and end of the last period, the amount of steam consumed during period, the amount consumed per day, the cost of heating for period, the cost of heating per day and the amount it should cost them per day with good regulation. There are also suggestions placed on the card as to how the customer could effect the saving with better regulation.

"Information of this kind has created a very good feeling of the customers toward the companies who are using these methods. That is only one suggestion as to the little things which could be done by the public service companies at very little cost to them, which, in the long run, would benefit both parties.

"There is one other point which I wish to bring out while I am on this subject, and that is the importance of the condition, the kind and the construction of the customers' heating system. I have probably harped on this subject too much in the past, but I have always thought, and still think, that the interior piping in the customers' buildings has more to do with the success of the district heating company than any other one thing. As one example of this, I wish to give you some data on one building which shows this fact up very plainly. The customer in question operates a nine-story department store, a four-story warehouse and a two-story garage. They are operating under a very low flat rate contract, which does not expire until about the year 1921, and in which there is a clause stating that any radiation which is added in new buildings or additions to the old ones during the period of the contract will be taken at the same unit price per square foot of radiation. Two seasons ago this customer built a nine-story addition to the department store, and the heating company insisted that an atmospheric system of heating be installed in same.

"During the fall of 1913, while the building was in course of construction, the steam was supplied to same by meter rate. The customer moved into the new addition about December 1st of that year, and at the end of January the heating company discovered that if the customer kept up the same regulation of the heat for the entire season that they had the first few months they would run less than their flat rate. The customer was notified to that effect and signed meter rate for that part of the building for the remainder of the season and stated that if they ran less than their flat rate they would continue on the meter rate in the future. They ran $226.84 less from November 11th to the close of the season than they would have paid flat rate for the same period, which nets a saving of about 13% below the flat rate. They are now regulating the service in their old building to see if it is possible to beat their flat rate there also. I might also state that last season is the first season that the heating company has made a profit on the steam sold to this customer, as they, like all flat-rate customers who have the old one-pipe system installed in their building, use twice as much steam as they pay for."

SECRETARY-TREASURER'S REPORT.

Secretary-Treasurer D. L. Gaskill reported total receipts for the year of $3,408.60, which, with the balance at the beginning of the year, made a total of $4,381. The year's expenditures were $3,328.31, leaving a balance on hand of $1,052.69. The financial affairs of the society, the report stated, have never been in such satisfactory condition. The membership has been increased from 300 to 344.

Secretary-Treasurer Gaskill recommended the election of honorary membership of men whose achievements in the line of heating have been such as

to make them national or international in their reputation, especially such men who are so situated that they would not be eligible to regular membership in the association.

He also spoke of the increased number of inquiries from foreign countries for membership, showing the spread of the district heating idea in Europe.

Regarding the organization of the membership committee, the secretary expressed the opinion that the plan followed in past years of appointing a committeeman from each State was not a good one, and recommended that a committee of seven or nine members, selected particularly for their fitness and location, would accomplish more.

Still another recommendation of Secretary-Treasurer Gaskill was that the retiring presidents should be presented with some fitting memorial or emblem as an appreciation of their services.

The auditing committee, composed of D. S. Boyden and George S. Martin, reported the books in good condition and the accounts correct.

Secretary-Treasurer D. L. Gaskill then read a postal card from August Beaurrienne, a member of the association, now serving in the French army, announcing his inability to attend the convention. On motion, it was voted to send the greetings of the association to M. Beaurrienne.

The report of the executive committee contained the names of some sixty applicants who were elected to membership.

President A. H. Wetherell announced the appointment of a nominating committee, consisting of E. L. Wilder, chairman, Rochester, N. Y.; Fred B. Orr, Chicago, and C. H. Spiehlman, Dayton.

REPORT OF STATION RECORD COMMITTEE.

This concluded the preliminary business and the technical part of the session was then opened with the presentation of the Report of the Station Record Committee, by A. Biggs, of the Edison Illuminating Co., Detroit, Mich., chairman.

One of the features of the report was a list of "ten commandments" for the operation of a central heating station, as follows:

1. I am thy indeterminate heating franchise, given thee for the good of the city and only incidentally for thy gain.

2. Thou shalt not raise any monument to inefficiency in thy works, nor do any work without the city permit, nor let thy plant or thy system break down so that the city's children be deprived of warmth, neither shalt thou shut steam off early from the mains at the ends of winter, even for the saving of thy coal pile.

3. Thou shalt not violate the terms of thy franchise, for thy franchise is revokable upon thy bad behavior.

4. Remember the rainy days to keep a fund for them. In all the days that thou shalt labor and do all thy work, thou shalt be diligent that thy excavations be quickly closed, that thy dirt piles be in order and soon removed, and that the ditches by the roadside be unobstructed.

5. Honor the ordinances of thy city, and thy agreements made when I was written, that thy days may be long in this town which thy franchise has handed unto thee.

6. Thou shalt not drown thy customers with wet steam.

7. Thou shalt not have questionable alliance with other companies, or with the officials of the city.

8. Thou shalt not cease to barricade thy trenches in the public highway by day, nor to indicate them by lighted lanterns by night, nor shalt thou fail to save thy city from damages when any person stumbleth by thy works.

9. Thou shalt not carry soot from smoking chimneys upon thy neighbor's clothes line.

10. Thou shalt not covet thy customer's pocket-book, thy meters shall register within four per centum, they shall not spin and neither shall they stop altogether, lest they unduly increase some one's else proportion of thy operating expense.

The work of the record committee resulted in the collection of some 25 copies of franchises under which member companies are operating. The report was accompanied by a large table containing an analysis of nineteen different heating franchises showing their variations. These features were discussed in the re-

port in detail. An appendix contained considerable data on steam consumption in various buildings; also tables on cost of trenching operations.

Second Session, Tuesday Afternoon.

The afternoon session was opened with an address by J. F. Gilchrist, vice-president of the Commonwealth Edison Co., of Chicago, in which he traced the growth of the heating business in connection with the electric lighting business, which resulted, in his company, in the formation of the Illinois Maintenance Co., which was organized to operate existing plants in large buildings in Chicago. Mr. Gilchrist emphasized the point that the way to secure economy is to concentrate production, and that this applies to the economical burning of fuel, the economical purchase of fuel and the labor economy. He also spoke of the advantage of reducing the smoke nuisance and fire hazard. Economies were also to be obtained in the handling of fuel and ashes, while the difference in traffic is noticeable. Mr. Gilchrist presented some interesting coal figures showing that out of the 517,453,000 tons of coal burned per year in the United States, the central lighting stations used 17,375,000 tons; the street and electric railway systems used 10,078,000 tons; the steam railways, 100,000,000 tons; and all other users, 390,000,000 tons.

He stated that the comparatively small amount of coal consumed by the electric lighting and electric railway systems was all out of proportion to the amount of work done, showing the economies now being effected by them.

He also urged that the users of steam heating should be educated, and instanced the case where a district heating plant was in danger of being closed on account of lack of profits. When the matter was put squarely before the community there was no difficulty in securing rates sufficiently high to give a reasonable profit.

Mr. Gilchrist said that only the large individual producers of electric energy in their plants are holding out against the use of central station heat. He said we were just beginning to appreciate the wonderful possibilities of the business.

MODEL HEATING FRANCHISE PROPOSED.

Following Mr. Gilchrist's address the discussion was opened on the report of the station record committee.

Charles R. Bishop suggested the compilation of a model heating franchise. This idea was received with favor and, on the suggestion of Secretary Gaskill, the matter will be taken up by the Public Policy Committee and made the subject of part of its report next year.

REPORT OF PUBLIC POLICY COMMITTEE.

The report of the Public Policy Committee was then presented by D. L. Gaskill, chairman. Among the subjects discussed in the report were: Education of the public as to the cost and advantages of heating service; extension; appraisals; rates; municipal ownership; legislation and franchises. The report took a positive stand against municipal ownership. It was also declared that utility legislation is in its infancy and is illy adapted to the needs of the public and the utilities it affects.

Regarding the effects of municipal ownership, Mr. Gaskill mentioned specifically the operation of the city heating plant in Cleveland as showing the difficulty to make such plants profitable, this plant having shown a loss each year since its installation.

Mr. Wilder called attention to another risk that lighting and heating companies are now experiencing in connection with the introduction of the jitney bus, which, he said, was responsible, in many cases, for the poor showings of such companies.

NEW OFFICERS.

At this point the report of the nominating committee was presented, the entire ticket being elected at a later session, as follows:

President, David S. Boyden, Boston, Mass.

First vice-president, Byron T. Gifford, Grand Rapids, Mich.

Second vice-president, George W. Martin, New York.

Third vice-president, William S. Monroe, Chicago, Ill.

Secretary-treasurer, D. L. Gaskill, Greenville, O.

Members of executive committee: C.

F. Oehlman, Denver, Colo., and Thomas Donahue, Lafayette, Ind.

Third Session, Wednesday Morning.

Following the election of a number of associate members, the report of the Committee on Underground Construction was presented by H. A. Woodworth, chairman, of the Merchants' Heat and Light Co., Indianapolis, Ind.

This report proved one of the most interesting and valuable of the meeting. It was considerably broader than its title indicated, being a review of present practice in the selection of materials, installation and operation of district heating mains. A circular letter was sent by the committee to various companies affiliated with the association, asking for particular data. The replies showed that there was a wide variation in the methods used throughout the country, but a study of the data indicates that the variations are not due to geographical location or climatic conditions. This variation, says the report, illuminates the fact that the greatest need of the industry is closer attention to standardization.

The report proceeded to discuss each item and to present a suggestion for standard practice. A number of valuable charts were included, one being a graphical solution of the Unwin formula for the pressure drop in steam pipes. The condensation loss in underground pipe lines was treated at length, the data including a number of tests which agreed fairly closely with the losses usually figured.

A subdivision of the report was a discussion of "Evaluation of Heating Utilities in Indiana" by H. O. Garman, chief engineer of the Indiana Public Service Commission.

The committee expressed the opinion that the field of district heating is barely touched. It recommended that future committees strive to standardize underground construction.

The remainder of the report was devoted to descriptions of various types of underground pipe conduit now on the market, which were illustrated in each case.

In discussing the report A. C. Rogers referred to the committee's statement that the heat losses from underground pipes were greater in summer than in winter, and expressed the opinion that higher velocities would reduce these losses and accomplish practically the same results.

Byron T. Gifford stated that the greater amount of exhaust steam available in the summer time might account for the higher losses, due to the moisture in the steam.

George W. Martin confirmed the statement as to greater line losses in summer which, he said, was the condition observed in the pipe line tests conducted at the Hall of Records, New York, by Reginald Pelham Bolton.

Mr. Nutting, in discussing the report, proposed the appointment of a committee to study the actual cost of manufacturing steam.

The next paper was on "Operating Experience with Bleeder Type Turbines," by F. W. Laas, chief engineer for the Iowa Railway & Light Co., Cedar Rapids, Ia. In the discussion several of the members, including Mr. De Wolf, Nutting and Shaw, gave the results of their own experiences with bleeder turbines, Mr. Shaw giving a number of instances of the successful use of this type, especially in hot water heating work.

Fourth Session, Wednesday Afternoon.

The report of the Educational Committee was the first business of the Wednesday afternoon session, and was presented by David S. Boyden, chairman. The divisions included "The Establishment of a Standard for Transmission Losses from Buildings of all Constructions," by Reginald Pelham Bolton; "The Establishment of Standard Methods of Proportioning Direct Radiation and Standard Sizes of Steam and Return Mains," by James A. Donnelly; "The Establishment of a Standard Coefficient for Heat Losses Effected by Wind Movement," by H. W. Whitten and R. C. March; and, finally, "The Establishment of Standard Heating Elements for Cooking Apparatus, with Special Reference to Low Pressure Heating," by D. S. Boyden.

The data contributed by Mr. Donnelly included proportionate requirements for other than the usual conditions, with reference to such items as radiator trans-

CONVENTION DINNER OF THE NATIONAL DISTRICT HEATING ASSOCIATION, HOTEL SHERMAN, CHICAGO, JUNE 2, 1915.

mission, amounts of radiation required and heat losses from buildings.

It is the intention of the committee to co-operate with a similar committee of the heating engineers' society in further developing the data obtained.

In discussing one matter brought out by Mr. Donnelly referring to the varying of the heat transmission factor for varying temperature differences, E. A. May stated that the experience of the Institute of Thermal Research of the American Radiator Company was that this coefficient did not vary as much as 2 per cent, as stated by Mr. Donnelly.

Mr. May presented some interesting figures bearing on radiator transmission. With an unpainted 38-in. radiator placed against the outside wall the coefficient was found to be 1.72. When a sheet of asbestos was placed between the radiator and the wall, the coefficient fell to 1.66. The radiator was then painted with aluminum bronze, and with the insulation taken away, the coefficient was 1.46, and with the insulation replaced, the figure became 1.42. Afterwards the same radiator was painted with a maroon japan and the coefficient jumped up to 1.7, without the insulation, and to 1.65 with the insulation.

Mr. May argued from these results that we are not yet prepared to decide on a standard transmission factor for radiators.

The section of the report devoted to cooking apparatus also brought out an extended discussion, and it was shown that this was a promising field of work for the central station heating man and that the manufacturers of such apparatus had little if any data regarding the operation of these appliances. It was brought out that the development of cooking apparatus suitable for use with low-pressure steam of 10 lbs. or less has already been accomplished on the Pacific Coast in spite of a manufacturer's statement that "it can't be done."

A paper was then presented on the "Commercial End of the Heating Business," by C. F. Oehlman, of the Denver Gas & Electric Co. A statement in this paper that "the heating department will in no way be responsible for the proper operation of a system brought forth some remarks from C. A. Gillham, who cited a number of experiences of the New York Steam Company showing improper installations which were the cause of complaints by the consumers on their heat bills which the company remedied to the advantage of all concerned. He strongly advocated the practice by heating companies of supervising the installation and operation of the plants. Mr. Gillham's experience was borne out by President Wetherell, who stated that in Peoria, Ill., the heating company made it a practice to design the plants to which its service was connected.

President Wetherell then called for a vote on the report of the Nominating Committee, and the nominees were elected unanimously. President-elect D. S. Boyden was called on for a speech, to which he responded by pledging his efforts to a continuation of the association's successful career. First Vice-President-Elect Byron T. Gifford also spoke, expressing his appreciation of the honor conferred, and his deep interest in the association's welfare.

Fifth Session, Thursday Morning.

Thursday morning's session was opened with the reading of a paper by W. G. Carlton, engineer, on "The Hot Water Heating System at the Grand Central Terminal." The paper was a condensed description of this extensive plant which supplies buildings having a total capacity of 50,000,000 cu. ft.

The method described for measuring the heat supplied through the use of Venturi tubes, in conjunction with recording thermometers, brought out a discussion as to whether this method could be generally applied in central station hot water heating work. Mr. Carlton stated that the smallest customer on the Terminal plant had 12,000 sq. ft. of radiating surface. He expressed the opinion that this method would be prohibitive in cost of operation if applied to small consumers.

Another question as to why hot water was chosen as the heating medium in the Terminal was answered by Mr. Carlton, who said that the possibility of breaks in steam mains where railroad tracks were located, which might result in clouds of

vapor, made it advisable to choose the hot water system.

In the ensuing discussion, Joseph Harrington, a boiler room expert, declared thant 70% of boiler plant operation can be improved upon from the standpoint of increased efficiency. Combustion efficiency, he added, is being rapidly reduced to an exact science. Among the principal agencies for improving boiler plant operation, he mentioned water softening, water purification, the use of recording instruments and daily reports.

Mr. Harrington said the practice of five or ten years ago was not the criterion of present-day practice. In this connection he mentioned the possibilities in the use of powdered coal for fuel, which, he said, was a coming practice within a comparatively short time.

Mr. Higgins also emphasized the possibilities of powdered coal and reviewed present practice in its manufacture and use.

J. G. De Remer, discussing the report in a general way, declared that district heating is the greatest undeveloped monopoly and, referring to a statement that many of the central heating companies were not making a profit, he expressed the opinion that if the data of these plants could be analyzed by a suitable committee, the companies could be placed on a profitable basis.

He urged the association to appoint a committee to take up such matters.

The fallacy of secret operation of heating plants, he said, has been eliminated, largely due to the publicity as to records required by the public service commissions. He suggested the name of such a committee to be the "consulting staff" committee. Mr. De Remer also urged the district heating companies to appoint "heating solicitors" to get after prospective customers.

Sixth Session, Thursday Afternoon.

Owing to the lateness of the hour the discussion of station operating committee's report was carried over to the afternoon session, when it was further discussed by Messrs. Nutting, Vater and Gifford.

A paper was then presented by C. C. Wilcox, engineer for the Hodenpyl Hardy Co., Jackson, Mich., on "A Pressure Survey Study Constituting a Report on the Comparative Use of Exhaust and Live Steam for Heating." The paper described a series of experiments carried on by the Central Illinois Light Co., near Peoria. The tests, which were given in considerable detail, indicate that if a like amount of heating is accomplished, it requires no more live steam than exhaust steam to do it; in fact the indications are just the reverse.

This paper opened the general subject of the comparative heating value of live and exhaust steam. George W. Martin, of the New York Service Co., was down on the programme for a paper on "Exhaust Steam vs. Live Steam for Heating," which he contributed as part of the discussion. Among others who participated were C. R. Bishop, D. S. Boyden, J. G. De Remer and Messrs. Nutting and Meyer.

All of the familiar instances were cited pro and con, and the subject was finally disposed of by referring it to a committee consisting of Messrs. George W. Martin, J. G. De Remer, C. C. Wilcox and Hobbs.

Before the meeting closed a motion was adopted, authorizing the executive committee to establish an association bulletin, to be published quarterly.

Following the passage of resolutions of thanks to the retiring president and committees and to the management of the Sherman Hotel, to the entertainment committee and to the exhibiting manufacturers, the meeting came to final adjournment.

THE EXHIBITS.

The most elaborate exhibition ever seen in connection with a convention of the National District Heating Association was held in the Louis XVI room, immediately adjoining the convention hall. About twenty manufacturers were represented by displays.

To add to the attractiveness of the scene the booths were partitioned off with hollow steel tubing, decorated with ropes of white chenille, while the signs of the exhibitors were of a uniform style of mahogany effect. Located at different points along the tubing were shields in the form of keystones bearing the emblem of the National District Heating Association in gold tinsel. The

arrangement of the booths was made by the National Exhibit Bureau, of Chicago.

Consolidated Engineering Co., of Chicago, had an elaborate display of an electrically-operated fractional valve connected to a glass radiator showing the method of controlling the steam supply to the radiator. There was also an electric-driven boiler feed pump in operation. The company's line of steam specialties used in connection with the Van Auken vacuum heating system and the Thermograde modulation heating system were also shown. The company's representatives present were B. Van Auken, president; John F. Hale, vice-president and general manager; H. Tyler Kay, advertising manager; and A. H. Probst, superintendent of installation.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa., had an exhibit of photographs showing different types of generating units, including straight condensing, non-condensing, bleeder type and geared units; also surface and jet condensing equipments, including a 30,000 k. w. surface condenser and a 25,000 k. w. jet condenser. L. S. Shaw represented the company.

Detroit Lubricator Co., Detroit, Mich., showed various types of the Detroit packless radiator valve and the Detroit multiport valve, including globe, gate, angle and corner valves. R. H. Lindman was in charge.

National Air Cell Covering Co., Brooklyn, N. Y., had a full-size standard double thick section of Pyro-Bestos underground pipe covering, with underdrain of glazed tile which acts as both drain and support. The equipment also included a ball-bearing pipe guide. Sections of single and double thick Pyro-Bestos pipe covering were also shown, in addition to a sample of Pyro-Bestos cement. G. Clarence Hall had charge of the exhibit.

American District Steam Co., No. Tonawanda, N. Y., showed a model of its underground pipe casing and also a sectional model of the company's multi-cell underground pipe construction. The exhibit also included its line of underground fittings, and Adsco steam specialties for the Atmospheric system of heating. The company's delegation consisted of W. H. Wells, president; C. R. Bishop, general manager; and H. C. Kimbrough, H. A. Austin, R. C. Holly, J. G. De Remer, Lloyd Howell and C. A. Dudley.

J. C. Hornung, Engineer, Chicago, showed types of his pressure and temperature controlling valve for steam, a broken model of his differential and temperature control valve for hot water; also the B. C. condensation trap, the central station special expansion joint, tank regulator, and his all-asbestos broken-jointed method of underground pipe conduit and insulation for steam and hot water. Those on hand in the interest of this exhibit were J. C. Hornung, D. T. Wallace and A. E. Schad.

Jenkins Bros., New York, had a display of its line of valves and packings, including the impulse valves and differential valves used in the Positive Differential system of steam heating. H. B. McLelland was in charge of the exhibit.

Tyler Underground Heating Systems, Pittsburgh, Pa., had a well-planned exhibit, consisting of a model of the Tyler multiple tunnel construction, including brackets, angles and expansion joints; also a sample of the one-pipe ditch construction, including anchors, expansion joints, casing, and pipe supports laid in concrete and arranged so that the pipe could be rotated. There were also Tyler condensation meters of 400 and 1,800 lbs. capacity per hour, and Tyler single and double expansion joints. The company's delegation consisted of E. B. Tyler, George A. Schmidt, Walter K. Long, M. E. Hathaway, J. S. Ward, and John E. Lord.

Republic Flow Meters Co., Chicago, had a recording steam meter in operation connected to the laundry on the thirteenth floor of the hotel. The company displayed types of its steam, water, air and gas meters, single tube manometers, long-distance pressure recorders and indicators; also indicating air and gas meters and the Spitzglass slide rule. The company was represented by J. D. Cunningham, John Norwornik, J. M. Spitzglass and A. Henderson.

V. D. Anderson Co., Cleveland, O., showed sectional models of the model D steam trap, steam and oil separator, high and low water column, alarm water column, oil filter and air trap. Charles H. Fiske and Leslie B. Fiske had charge of the exhibit.

Boylston Steam Specialty Co., Chicago, Ill., showed broken full-sized models of its line of steam traps, pressure regulators, vacuum governors, and pilot valves. John Boylston, Sr., John Boylston, Jr., and H. J. Richter looked after the company's interests.

Central Station Steam Co., Detroit, Mich., had a Detroit condensation meter in operation, with a capacity of 450 lbs. of condensation per hour, or large enough to take care of 1,500 sq. ft. of direct radiation. The company's exhibit also included a section of a diaphragm type expansion joint 4 in. in diameter. Those on hand for the company

were J. V. Redfield, president and general manager; W. R. Owen and F. A. Green.

Illinois Engineering Co., Chicago, Ill., had on exhibition types of its graduated radiator supply valves and thermo return valves and float return traps; also pump and pipe strainers and oil separators. The company was represented by J. C. Matchett, R. L. Gifford and F. Van Inwagen.

American Radiator Co., Chicago, Ill., showed a working model of its regitherm in connection with a Sylphon reducing valve, for central station heating work. This appliance attracted much interest on account of the fact that no auxiliaries are used in its operation. The exhibit also included samples of Sylphon packless valves. Those representing the company were C. J. Swan, F. C. Reeder and A. K. Root. E. A. May, the company's boiler expert, was also present in his capacity as a member of the heating engineers' committee which was appointed to confer with the educational committee of the National District Heating Association. J. H. Davis was also present.

Michigan Pipe Co., Bay City, Mich., showed different sizes of the Michigan tin-lined underground wood pipe covering, with shells of 2 in., 3 in. and 4 in. in thickness. Harry B. Smith, Jr., had charge of the company's interests.

G. M. Davis Regulator Co., Chicago, were among the exhibitors, displaying aluminum sectional models of the Davis Class C non-return valve, pressure regulator, balance valve, float valve, damper regulator, noiseless back pressure valve, relief valves for condensing engines, continuous flow steam trap, and automatic choke valve for diverting flow of water in central heating plants.

Armstrong Cork & Insulation Co., Pittsburgh, Pa., had on exhibition samples of Nonpareil high-pressure steam pipe covering and of Nonpareil heat insulating brick. There was also a model of a boiler setting insulated with one course of 4½-in. insulating brick, and a section of underground steam line construction, with split-tile protection, the Nonpareil pipe covering being supported by pipe rollers. Those present for the company included W. A. Speelman, E. N. Heidkamp, G. G. Oetting and H. E. Moon.

A. Wyckoff & Sons Co., Elmira, N. Y., had an exhibit showing the old and new 8-in. construction of its wood steam pipe covering. E. M. Peter and Emory E. Peter were in charge.

H. W. Johns-Manville Co., New York, exhibited a full-size model of the J.-M. underground sectional pipe conduit, together with many of its electrical specialties, including electrical fibre conduit for running electric wires underground, the Noark line of fuses and boxes; also pipe insulation and packing. Those on hand for the company were H. W. Frantz, George Becker and H. F. Newell.

Cannelton Sewer Pipe Co., Cannelton, Ind., showed two models of the Cannelton method of insulating and supporting underground steam and hot water lines. One of the models showed the offset tee used with this type of construction. The company was represented by C. A. Clemens.

The Entertainment.

An entertainment program, remarkable for the completeness of its details, was carried out by a committee consisting of Harold Almert, chairman: Fred B. Orr, L. S. Shaw, Oliver H. Hogue, George H. Jones, John G. Learned, J. L. Hecht, H. S. Hart, Charles H. Fiske and H. B. Braydon.

On Tuesday afternoon the ladies were entertained at a musical and card party at the Hotel Sherman. In the evening the members and guests took in the show at the Majestic Theatre.

Wednesday morning was devoted to a shopping tour for the ladies and in the afternoon they were taken in automobiles for a ride about the city and thence to the Midway Gardens where they were entertained with some clever dancing by professional talent.

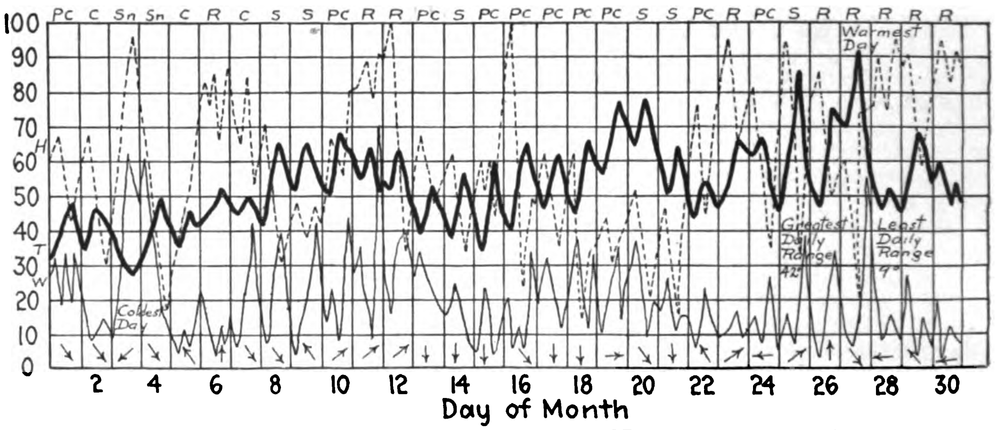
Wednesday evening was devoted to the convention dinner and dance at the Hotel Sherman. Every detail had been carefully worked out under the immediate direction of L. S. Shaw. During the dinner itself a male quartette and two young lady singers entertained the company. Later the guests adjourned to the exhibition hall while the dining hall was cleared for dancing. As they passed into the exhibition hall they were invited to witness the feats of a sleight-of-hand artist who proved himself well worthy of the name.

By this time the ballroom was ready for business and the remainder of the evening was spent most enjoyably with both old and modern dances, interspersed with exhibition dancing by professionals. The entire affair was so admirably planned and carried out that the company was enthusiastic in its appreciation and approval.

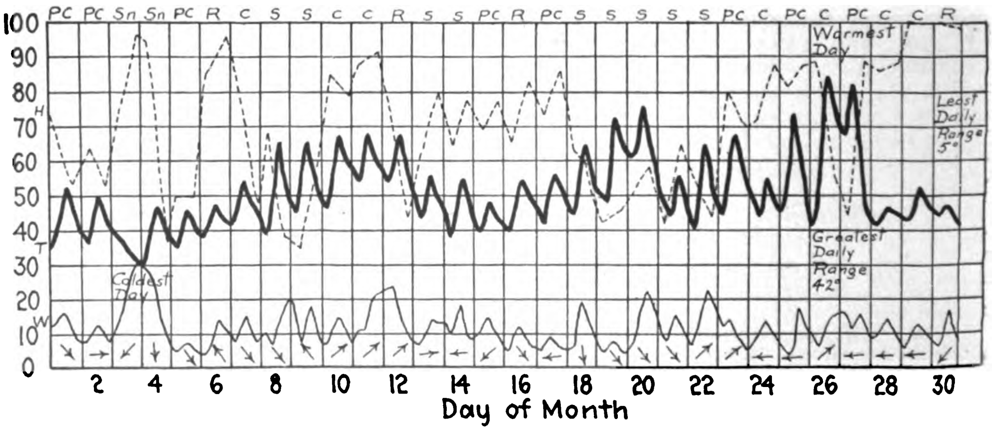
Thursday morning was spent by the ladies in visiting some of Chicago's big stores and in the afternoon they were taken for an excursion on Lake Michigan on board the U. S. Training Ship, Isle de la Luzon. A buffet luncheon was served on board.

The Weather for April, 1915.

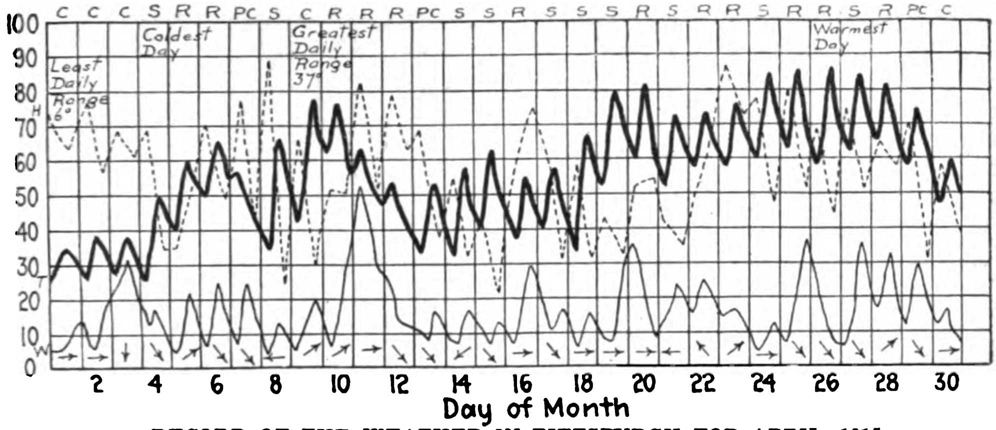
	New York	Boston	Pittsburg	Chicago	St. Louis
Highest temperature, degrees F...........	91	84	87	88	86
Date of highest temperature...............	27	26	26	26	27
Lowest temperature, degrees F............	28	30	26	30	30
Date of lowest temperature...............	3	3	4	4	3
Greatest daily range, degrees F............	42	42	37	28	26
Date of greatest daily range..............	25	26	9	20	7
Lowest daily range, degrees F.............	9	5	6	4	8
Date of least daily range..................	28	30	1	3	1
Mean temp. for month, degrees F.........	53.4	51	56	56	63.2
Normal mean temp. for month, degrees F..	48	45.3	51	45.9	56.1
Total rainfall, inches......................	2.1	1.86	1.27	1.02	1.2
Total snowfall, inches.....................	10.2	6.1	..	..	..
Normal precipitation, this month, in.......	3.3	3.55	2.9	2.88	3.52
Total wind movement, miles..............	11959	7699	7718	8582	9782
Average hourly wind velocity, miles.......	16.6	10.7	10.7	11.9	13.6
Prevailing direction of wind..............	N.W.	N.W.	N.W.	S.	S.
Number of clear days......................	7	10	10	15	18
Number of partly cloudy days.............	14	8	6	10	8
Number of cloudy days....................	9	12	14	5	4
Number of days on which rain fell........	12	6	12	9	8
Number of days on which snow fell.......	2	2	..	..	..
Snow on ground at end of month.........	..	..	..	..	..



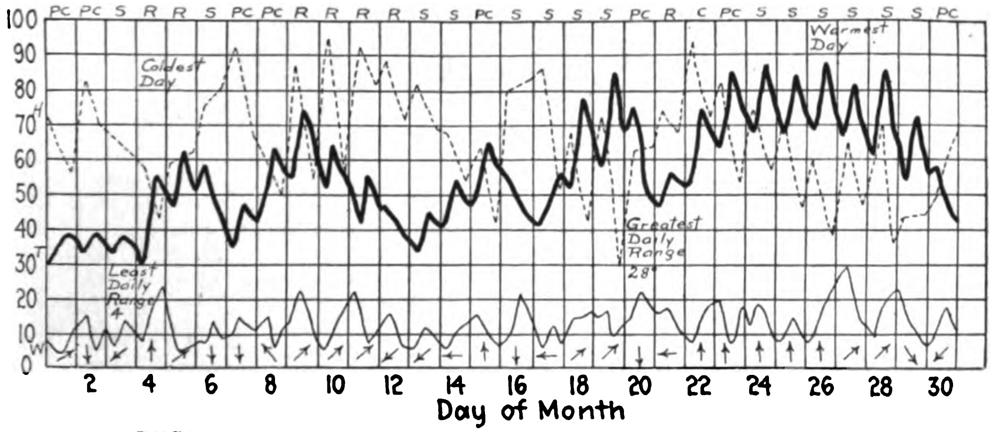
RECORD OF THE WEATHER IN NEW YORK FOR APRIL, 1915.
(Relative Humidity Curve is Plotted from Hourly Observations.)



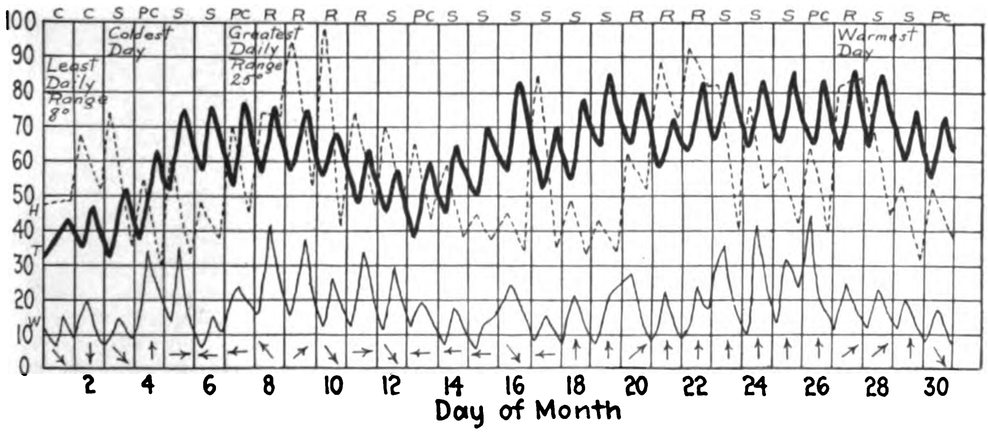
RECORD OF THE WEATHER IN BOSTON FOR APRIL, 1915.



RECORD OF THE WEATHER IN PITTSBURGH FOR APRIL, 1915.



RECORD OF THE WEATHER IN CHICAGO FOR APRIL, 1915.



RECORD OF THE WEATHER IN ST. LOUIS FOR APRIL, 1915.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

46—Testing House Heating Boilers and Checking Manufacturers' Ratings.

QUESTION: Do you know of any simple and ready method of determining the capacity of small house heating boilers and checking manufacturers' ratings?

ANSWER: This is a very pertinent question. Except in a few cases, none of the boiler catalogues gives the number of square feet of fire surface and, therefore, it is difficult to tell how large a boiler is in a given case. The size of the grate is given, but this has little or nothing to do with the size and amount of the heating surface in the boiler proper, as with a high intensity of fire and little heating surface the boiler can be made to do work beyond its ordinary capacity. There is also a clause in most boiler catalogues stating that "owing to the varying conditions under which the boiler is used, the boiler is not guaranteed beyond furnishing new castings, due to defects in manufacture" for which it is often impossible to hold the manufacturer.

Nearly all catalogues, however, give a rating in square feet of direct radiation based on a heat emission of 250 B. T. U. per hour per square foot of surface. It should not be overlooked, however, that these ratings may mean a flue temperature around 700° F., which, of course, would entail a waste of fuel.

Some catalogues give the evaporation per pound of fuel, based on 80% of the coal burned and in one notable case a four section, a five-section and a six-section boiler, all of the same type, are credited with 8 lbs., 8.5 lbs., and 9 lbs. of water evaporated per pound of fuel. This means that the last mentioned boiler is 12.5% more economical than the first boiler and, therefore, overrated in the first case.

The following is offered as an easy and non-technical method of making a test that will determine the rating of a boiler along the lines followed in boiler catalogues, eliminating all pipe covering and radiation, except the covering of the boiler.

Disconnect the main steam pipe and make a 1 in. or 1¼ in. connection to the steam outlet of the boiler with a valve, in such a manner that the water can be drawn as heated into one of two barrels set beside the boiler. The city water is already connected, with valve, for the supply. Place two thermometers that have been compared in tees, one in the feed pipe and one in the overflow pipe. Provide two barrels calibrated so that the exact weight of water at the final temperature is known when it reaches a certain mark on the barrel. If platform scales are handy and the weight of the barrels is known, the barrels do not need to be calibrated.

Get the fire in an observed condition and charge with fuel, so operating the boiler and fire that it will be in the same observed condition at the end of the test and interval of time. Weigh the coal or fuel if desired.

Run the water through the boiler so that all the water is heated from the hydrant temperature to say, 210° F., and vary the flow with the valves so that this difference will be as nearly constant as possible throughout the period of the test.

At the end of the period multiply the weight of water by the difference in temperature and divide by the time in hours. The result will be the B. T. U. per hour supplied by the boiler. If the boiler is rated on a heat transmission of 250 B. T. U. per hour per square foot of surface, the total B. T. U. divided by 250 will determine the rating of the boiler.

It is desirable to use a flue thermometer and burn the fuel so that the gases will not go out over 400° or 450° F., which can be done by regulating the draft.

Most of the high ratings reported are obtained by running an intense fire, with high flue temperatures, which is poor economy. The difference between the economy of high flue temperatures and low flue temperatures, however, is not more than 10% or 15%, but it means attention to the fire at more frequent intervals.

The test here outlined may be applied to hot water boilers as well as to steam boilers, but in that case the water boiler rating would be obtained by dividing by 185 B. T. U., instead of by 250 B. T. U.

Say we obtain 900 lbs. of water flowing through the boiler per hour and the outboard temperature is 210° F. with the city water entering the boiler at 50° F. In that case the weight, multiplied by 210—50=160°, is 900×160=144,000 B. T. U. per hour. The rating of the boiler should then be 144,000÷250=576 sq. ft. for steam and 144,000÷185=778 sq. ft. for hot water.

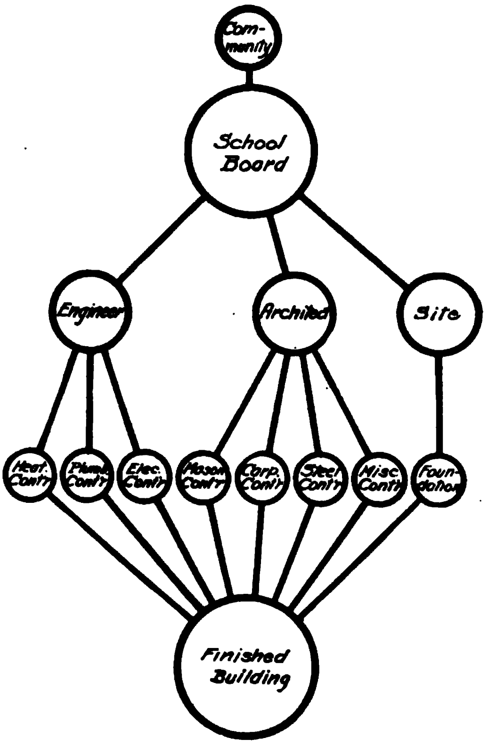
When the boiler is so large that the flow of city water requires an unusually high outboard temperature, the method here proposed would no doubt become cumbersome, and an evaporation test might be required. As most of the trouble is with the smaller house heating boilers, this test will usually answer the purpose. From the manufacturers' standpoint this test should be a favorable one. Due to the lower temperature of the medium, the heat absorption should be at a higher rate than when making steam, although there will not be much difference. The steam boiler, of course, should be full of water while the test is being made.

If any steam fitter or house holder desires to make tests of the character outlined, we shall be glad to analyze the data in this department. The principal expense would be the cost of the thermometers, $5 to $10, depending on the degree of accuracy desired. Thermometer cups, with mercury, set in tees, should be used and thermometers with graduations on the glass direct are desirable. After the thermometers are purchased, the only expense would be the time and barrels for measuring the water.

Business Organization in Schoolhouse Construction.

In an article by Harold L. Alt in the *School Board Journal,* the author presents an interesting diagram, which is reproduced herewith, showing what he terms the normal business organization of school construction and one which will give satisfactory results. As will be noted, in this arrangement, the community appoints the school board which, in turn, selects the site and the architect and engineer. The site, according to the safe bearing load of the soil, determines the foundation and the architect should not be held responsible for expensive foundations necessitated by poor bearing soil.

The method of operation indicated by the diagram is as follows: After the contracts are let, the engineer controls the heating, plumbing and lighting contractors' work, while the masonry, carpentry, steel, painting, plastering, roofing and miscellaneous work would be under the control of the architect. The work of these contractors, it is pointed out, is united to form a finished and complete building and all disputes are carried back through the architect or engineer to the school board for its judgment.



NORMAL BUSINESS ORGANIZATION OF SCHOOL CONSTRUCTION.

"It is better," says the writer, "that the engineer be selected and appointed by the board as he is then better able to serve the board's interest alone when he is selectd by the architect and is, therefore, under obligations to him. It goes without saying, however, that the selection of an engineer who is antagonistic to the architect is not good business policy since they must co-operate."

Improvement in Building Operations.

Building construction in the United States during March, 1915, in 101 of the leading cities, totaled $68,406,846, which is 12 per cent below the corresponding figures for March, 1914. New York City reported a loss of 22 per cent; Chicago, a loss of 4 per cent; Philadelphia, a gain of 4 per cent; Boston, a gain of 4 per cent; Brooklyn, a gain of 15 per cent; Cleveland, a loss of 1 per cent; Detroit, a gain of 23 per cent; San Francisco, a loss of 64 per cent; Minneapolis, a loss of 34 per cent; Cincinnati, a gain of 57 per cent; St. Louis, a loss of 12 per cent; Los Angeles, a loss of 48 per cent; and Pittsburgh, a gain of 5 per cent.

The American Contractor, of Chicago, says: "The March showing of building operations throughout the country is not without its good points to those who are not extravagant in their expectations. There is a shrinkage as compared with March of last year, amounting to 15 per cent, but the total is increasing steadily month by month. Thus the January footings were $34,712,718; those for February, $40,872,773; while March yields activities represented by $53,162,521."

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter Holds Annual Dinner.

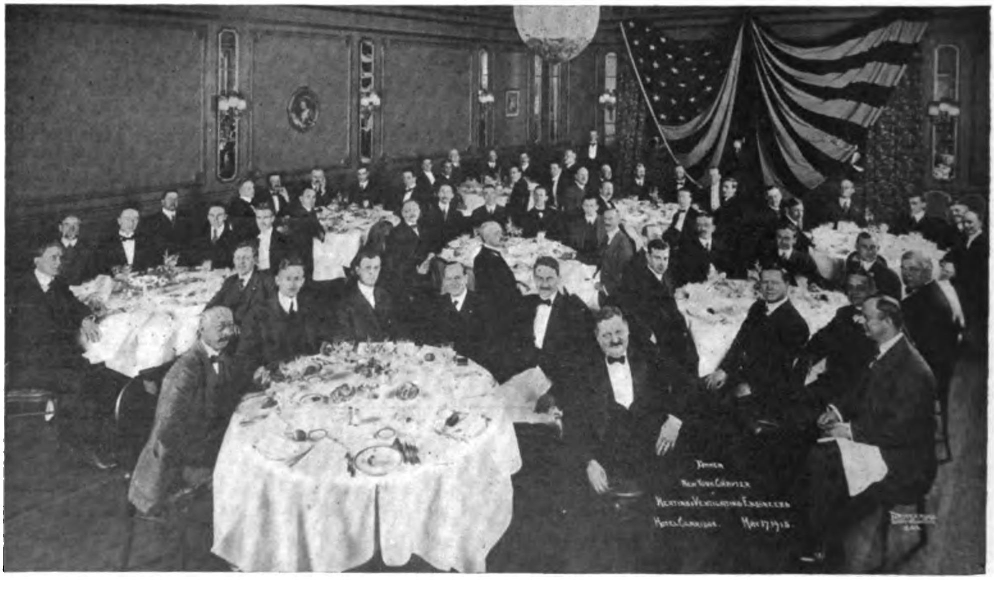
The staid demeanor of New York heating engineers underwent a severe test when the annual dinner of the New York Chapter of the American Society of Heating and Ventilating Engineers was "put across" at the Hotel Claridge, New York, May 17. Covers were laid for sixty members and guests, but, as it turned out, the diners and even the dinner itself, were as mere incidents in connection with the affair. The dinner committee had secured the services of Billy Murray and the engineers' quartette, who were accompanied by Franzen's orchestra, and also Miss Vera Letta and Miss Alta Cron. The combination proved irresistible and between these artists and the "slaughter house quartette," made up of local talent, the entertainment programme left little to be desired.

When the revelry had partially subsided, the retiring president, Walter S. Timmis, expressed his pleasure over the success of the dinner and stated that advantage would be taken of the opportunity to install the new chapter officers. The incoming president, William H. Driscoll, who was the first to respond, announced an interesting programme of meetings in course of preparation for next winter and then called on the other new officers to say a few words. Vice-President Arthur Ritter and Treasurer William J. Olvany responded and Secretary J. J. Blackmore, of the society, spoke for F. K. Davis, the new chapter secretary, who was unable to be present. Others who spoke were D. D. Kimball, Frank K. Chew, William J. Issertell and A. S. Armagnac.

The committee in charge of the dinner arrangements, which were carried out so successfully, was composed of W. H. Driscoll, chairman; George W. Knight, Charles E. Scott and George G. Schmidt.

Illinois Chapter Hears Report of Air Washer Committee.

A stereopticon lecture on dust and air washers, delivered by Dr. E. Vernon Hill, as chairman of the air washer committee, was the feature of the May meeting of the Illinois Chapter, held at the Great Northern Hotel, Chicago, May 10. The lecture followed the usual chapter dinner, which was attended by more than thirty members and guests. Dr. Hill spoke first on the general



NEW YORK CHAPTER DINNER, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, AT THE HOTEL CLARIDGE, NEW YORK, MAY 17, 1915.

subject of dust and showed its importance in the scheme of the universe. He then explained how fog, rain and snow are produced through the condensation of moisture on the dust in the air.

Slides were then shown of the experimental air-washing plant on the roof of the Chicago City Hall. Here an effort is being made to determine a simple method of making air tests which can be adopted as standard, rather than to make comparative tests of the efficiency of the different air-washers themselves. The present procedure is to preserve the air that passes through the air-washer in bottles of distilled water. The water is subsequently evaporated and the residue dried and analyzed. Dr. Hill stated that some interesting results are anticipated from the tests in the near future. The present equipment includes a Webster air-washer.

The routine business transacted included the appointment by President Newport of a nominating committee, composed of E. J. Claffey, C. W. Johnston and J. F. Tuttle.

Massachusetts Chapter Closes Its Season.

The last meeting of the Massachusetts Chapter for the season was held May 12, when a committee of three was appointed to draft a programme for next season. One of the first subjects will be a stereopticon lecture on the heating system in the new buildings of the Massachusetts Institute of Technology, to be delivered by George Libby. The committee at work on the programme is composed of Messrs. Smallman, Boltz and Morrison. The chapter appointed Major James W. H. Myrick as its delegate to the summer meeting of the society at San Francisco in September. The proposed amendment to the chapter's by-laws, changing the date of the annual meeting from October to May, was laid over until the next meeting in the fall.

The election of the following new members of the American Society of Heating and Ventilating Engineers is announced:

MEMBERS.

Alfred D. Alexander, Bessemer Bldg., Pittsburgh, Pa.
Orrie H. Allinson, Jobstown, N. J.
George E. Black, Parliament Bldgs., Toronto, Ont.
George Boon, 1708 Arch St., Philadelphia, Pa.
John H. Brown, Public Works Dept., Winnipeg, Man.
Clyde W. Colby, 464 Spitzer Bldg., Toledo, Ohio.
Jesse Coogan, 404 State St., Salt Lake City, Utah.
Linwood B. Cornell, 88 Union Ave., Portland, Ore.
Arthur P. Goldsmith, 108 So. 18th St., Philadelphia, Pa.
Irwin F. Grumbein, 785 Drexel Bldg., Philadelphia, Pa.
Edward M. Harrigan, 231 First St., Detroit, Mich.
Laurence H. Henschen, 109 Bluff St., Joliet, Ill.
Donald B. Howard, Des Moines, Ia.
Herman D. Jackes, 278 Franklin St., Bloomfield, N. J.
Otto J. Juttner, 434 Jefferson St., Milwaukee, Wis.
Charles W. Kimball, 6 Beacon St., Boston, Mass.
Walter Klie, 1133 Bolivar Rd., Cleveland, Ohio.
Nicholas J. Mathey, Le Mars, Ia.
Edward T. Murphy, 734 Real Estate Trust Bldg., Philadelphia, Pa.
George B. Nichols, State Capitol, Albany, N. Y.
Lee Nusbaum, 1119 N. Howard St., Philadelphia, Pa.
George T. Palmer, City College, 139th St., New York.
A. J. Purcell, P. O. Box 728, Little Rock, Ark.
Samuel F. Richards, 1008 Mutual Assurance Bldg., Richmond, Va.
C. M. Ripley, 15 West 38th St., New York City.
Samuel F. Smith, 4425 Euclid Ave., Cleveland, Ohio.
Charles W. Tholen, 821 Plymouth Bldg., Minneapolis, Minn.
Louis S. Thomason, 353 East 14th St., Brooklyn, N. Y.
William H. Timm, 305 Abbott Bldg., Philadelphia, Pa.
R. H. Trane, La Crosse, Wis.
Louis H. Tripp, 1729 New York Ave., N. W., Washington, D. C.
Herbert R. Voelcker, 506 Y. M. C. A. Bldg., Houston, Texas.
J. Walter Williams, 213 East Seneca St., Ithaca, N. Y.

ASSOCIATE MEMBERS.

Samuel A. Armstrong, Parliament Bldgs., Toronto, Ont.
Maxwell F. Gilbert, 1342 Arch St., Philadelphia, Pa.
Frank P. Keeney, 445 Plymouth St., Chicago, Ill.
Neal W. Taplin, 123 Liberty St., Grand Rapids, Mich.

JUNIOR MEMBERS.

Morris Klaus, 1412 Prospect Ave., Bronx.
G. Richard Ludlow, 123 Cluster St., Mt. Vernon, N. Y.
Leon L. Munier, 31 Zabriskie St., Jersey City, N. J.
William E. V. Shaw, 750 Summit Ave., Milwaukee, Wis.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Programme for Twenty-seventh Annual Convention.

Arrangements have been practically completed for the twenty-seventh annual convention of the National Association of Master Steam and Hot Water Fitters which will be held in Milwaukee, Wis., June 21 to 24, with headquarters at the Hotel Wisconsin. Following is the programme:

MONDAY, JUNE 21.

10 a. m.—Meeting of Board of Directors.

TUESDAY, JUNE 22.

10 a. m.—Addresses of welcome by Mayor Bading and Judge J. C. Karel.

12 m.—Luncheon for women, Colonial Room, Hotel Wisconsin.

2 p. m.—Opening meeting, address on national defence by Mayor William Mather Lewis, of Lake Forest, member of the Navy League.

8 p. m.—Carnival night at the Badger Room, Hotel Wisconsin.

WEDNESDAY, JUNE 23.

10 a. m.—Executive session, for members only.

10 a. m.—Golf tournament at the Blue Mound Country Club for women and non-members attending the convention.

2 p. m.—Automobile trip through Milwaukee parks.

8 p. m.—Bowling tournament at the Kurtz alleys.

THURSDAY, JUNE 24.

10 a. m.—Election of officers.

2 p. m.—Boat ride on Lake Michigan.

The following committee from the Milwaukee Association will have general charge of the arrangements:

Edmund Grassler, representing Grassler & Gezelschaap; Fred Kaufman, representing Kaufman-Haas Heating Co.; Frank Downey, representing Downey Heating & Supply Co.; Hugo Franke; I. Harrimann, representing Thompson & Harrimann; Emil Henoch, representing Wenzel & Henoch; Albert Luebke, representing Schumann & Luebke; F. H. Meadows, representing Marvel Spencer Heating Co.

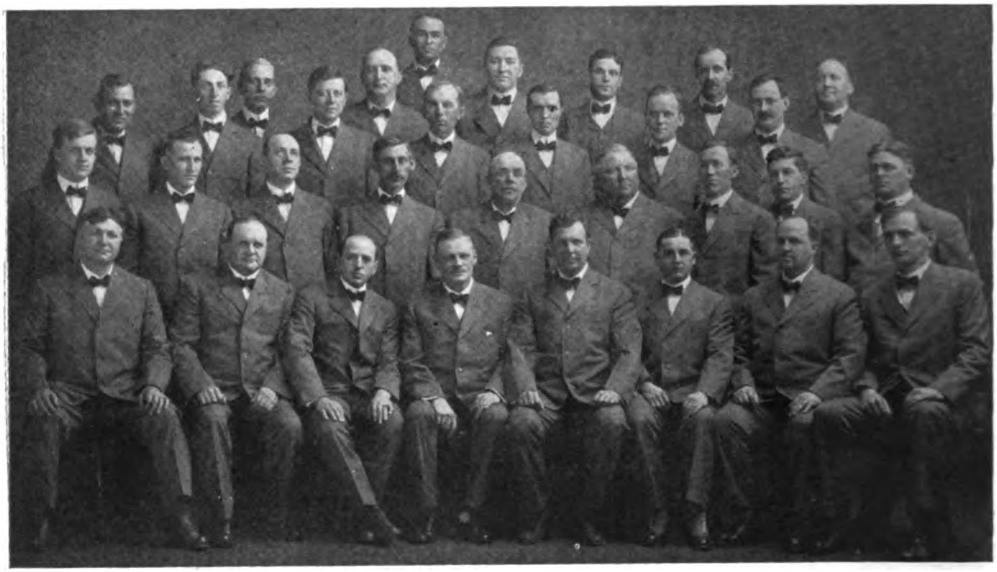
This general committee has appointed the following sub-committees:

Committee on Finance—Edmund Grassler, Frank Downey and F. H. Meadows.

Committee on Entertainment for Ladies—Wm. LaCompte, representing Jenkins Bros., of New York, as chairman, and J. B. Garfield, representing the American Radiator Co., New York, members ex-officio; I. Harrimann, Hugo Franke and Frank Downey.

Committee on Automobiles—Fred Kaufman, Emil Henoch and Albert Leubke.

The Elk's Club will keep open house for visitors during the convention.



MILWAUKEE'S ENTERTAINMENT COMMITTEE FOR THE FORTHCOMING CONVENTION OF THE NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS.

New York State Association.

New officers were elected as follows at the annual meeting of the New York State Association of Master Steam and Hot Water Fitters, which was held in New York City, May 11: President, N. Loring Danforth, Buffalo; vice-president, William H. McKiever, New York; secretary-treasurer, W. J. Olvany, New York; recording secretary, Henry B. Gombers, New York. Board of Directors: Edward F. Joy, Syracuse; John R. Sheehan, Schenectady; William H. Curtin, Brooklyn; Jeremiah R. Smith, Oneida, and George H. Drake, Buffalo. Among the guests of the association were Edmund Grassler, of Milwaukee, third vice-president of the National Association of Master Steam and Hot Water Fitters, and F. H. Meadows, secretary of the Wisconsin State Association.

It was voted to send a representative to Albany to urge Governor Whitman to veto Senate Bill No. 2073 as being inimical to the interests of the contracting steam fitter. Among other general matters that came up for discussion were the reports of conferences with State Architect L. F. Pilcher, relating to methods followed by his depart-

ment in calling for certified checks to accompany bids for state work; the state alien labor law, and reports of conferences with Cornell University officials relating to work to be done at that institution and its relation to the state laws.

Following the convention the members were entertained at dinner at the Building Trades Employers' Association Club by the New York City Association, where the features included a vaudeville programme.

Pennsylvania State Association.

Addresses on a number of important subjects connected with the trade were a feature of the twenty-sixth annual convention of the Pennsylvania State Association of Master Steam and Hot Water Fitters, held in Philadelphia, May 27. Among the subjects discussed were: "Cost Accounting Methods as Applied to Compensation and Other Laws About to Be Enacted in This State," "Establishing Uniform Practice As to the Requirement of Separate Specifications and Direct Bids for Plumbing, Heating, Ventilating and Electric Work on All Buildings." The speakers also took up efforts to standardize other difficult problems with the idea of improving conditions.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

AIR CONDITIONING—

Air Conditioning. J. Irvine Lyle. Supposed benefits from air washing and humidifying, and the application to various industrial plants; heating and cooling methods and machines. Ills. Discussion. 8,500 w. Pro Engrs' Club of Phila—Jan., 1915. 60c.

PIPING—

Drainage of Low-Pressure Piping. Charles L. Hubbard. Method of utilizing heat from oily drips, removing oil from exhaust and drainage of feed-water heaters. Ills. 1,200 w. Prac Engr, Chicago—March 1, 1915. 20c.

Economical Design of Low-Pressure Steam Mains. A. Langstaff Johnston, Jr. The laws governing the flow of steam in pipes are worked out for low-pressure installations, especially for steam-heating purposes, presented in graphic form for solving the special problems of any plant. 3,000 w. Engng Mag—April, 1915. 40c.

SATURATED AIR—

Properties of Saturated Air. W. D. Ennis. Underlying principles, method of computing table of properties of air saturated with moisture, with examples of applications of table. 1,500 w. Power—March 23, 1915. 20c.

VENTILATION—

Safety Through Good Ventilating Systems. Edward T. Walsh. Causes of vitiated air, effects, and methods of ventilation. Ills. 4,500 w. Safety Engng—March, 1915. 40c.

NATIONAL DISTRICT HEATING ASSOCIATION

Convention Notes.

An event for the men not on the regular program was the luncheon of the Electric Club at the Hotel Sherman on Thursday. A general invitation was extended to the delegates to be present and many availed themselves of the opportunity.

Also, under the guidance of Mr. Kelly, inspection trips were made by the men to the Fisk street power station and to some of the power and heating plants of the Illinois Maintenance Company.

The appearance of the new book on "District Heating," by S. Morgan Bushnell and Fred. B. Orr, at the convention, proved an interesting feature and the booth where copies were being sold was one of the much-visited spots in the exhibtion hall. Both Mr. Bushnell and Mr. Orr came in for many congratulations on their treatment of the subject, as well as on the fine appearance of the book itself.

The exhibition hall gossip included a report of the proposed organization of manufacturers of vapor steam heating systems, with the object of developing a trade name for such systems, such as "air return systems," and boosting their wider adoption by architects, engineers and contractors. It was reported that informal meetings of representatives of these manufacturers were now being held in New York at stated intervals.

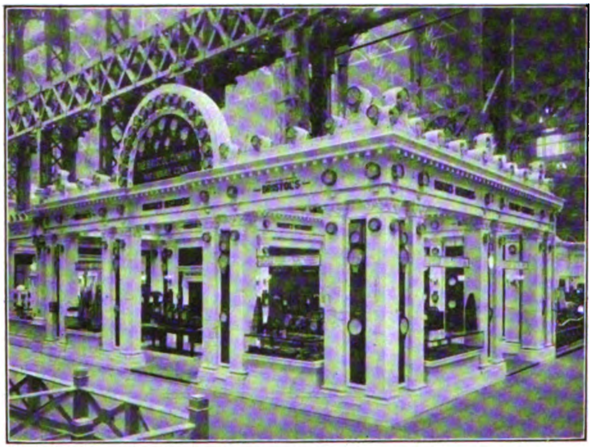
President David S. Boyden Entertains at Luncheon.

One of the pleasant features of the Electric Club luncheon at the Hotel Sherman on Thursday was a luncheon party given by the new president of the association, David S. Boyden, to the past presidents and some of the other members. His guests were Past Presidents A. C. Rogers, R. D. De Wolf, A. D. Spencer, S. Morgan Bushnell, and C. R. Bishop, A. P. Biggs, Secretary D. L. Gaskill, J. G. De Remer, Byron T. Gifford, George W. Martin and A. S. Armagnac.

Panama-Pacific International Exposition Exhibits.

1.—The Bristol Company.

The exhibit of the Bristol Company, of Waterbury, Conn., at the San Francisco exposition includes samples of its extensive line of recording instruments for pressure, vacuum, liquid level, differential pressure, temperature, electricity, time, motion, speed and humidity. The exhibit is located in the Palace



THE BRISTOL COMPANY'S BOOTH AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION, SAN FRANCISCO.

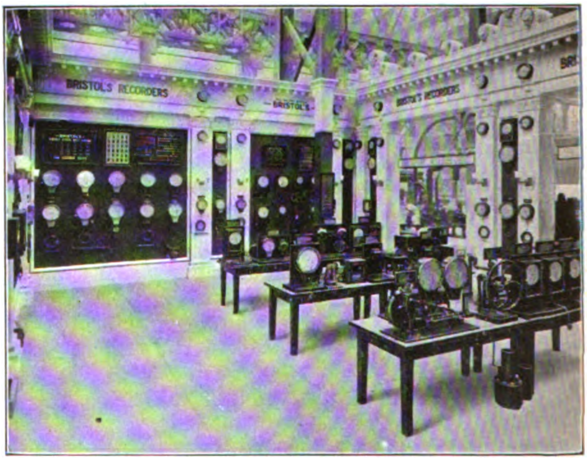
of Machinery in Section 32 and occupies a floor space 40x30 ft. The decoration of the superstructure of the booth, shown in the accompanying illustration, are actual models of Bristol recording instruments. On the lower part of the outside columns of the booth, working models of Bristol instruments are exhibited in operation, producing records of atmospheric temperature, the level of the tide in the bay, also records of conditions on the electrical circuits in the Palace of Machinery. Inside the booth the outfits include the new Bristol patent long distance electric thermometers. A booklet reproducing photographs of the complete booth, and each of the different sections may be had upon request, by addressing the company.

Use of Hot Condensation for Heating Domestic Water Supply.

Commenting on a discussion in last month's issue in the "Consulting Engineer" Department, on "Cooling Coils for Lowering Temperature of Condensation," H. W. Sims of the Sims Co., Erie, Pa., calls attention to the paragraph stating that "it is always policy to utilize this heat in some manner," and says:

"We have furnished a number of our heaters designed for this very purpose. using the hot condensation for heating water for domestic use. As a rule, the temperature of the condensation is reduced to a point very close to that of the cooling water, which is much more satisfactory for discharge to the sewer than a temperature near the boiling point.

"The most satisfactory method of accomplishing this result, we find, is the use of the type of heater shown on page 79; the lower bank of tubes is so arranged as to pass the water through small groups of tubes making several passes from inlet to outlet. These tubes are located in the bottom of the heater, therefore, in the coldest water, making the most effective heat transfer. We find in some cases that the heat absorbed from the hot condensation is alone sufficient to provide all the hot water required for domestic purposes at a satisfactory temperature. For summer use,



INTERIOR OF THE BRISTOL COMPANY'S BOOTH.

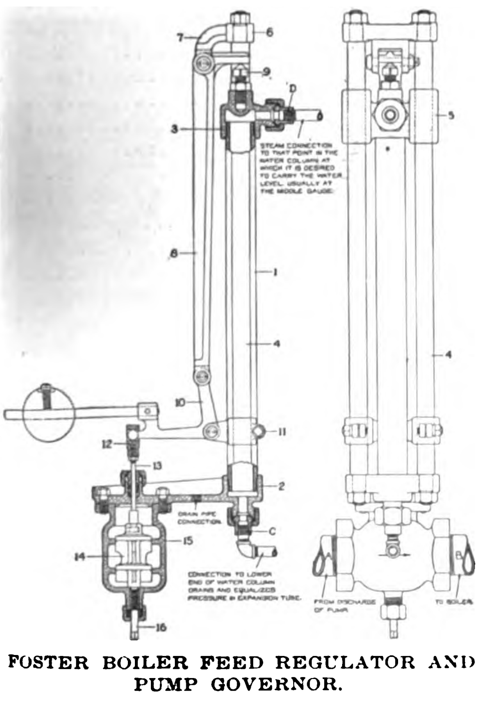
if live steam is available, a separate group of tubes can be used for water heating, or a gas heater may be connected, using the tank for storage.

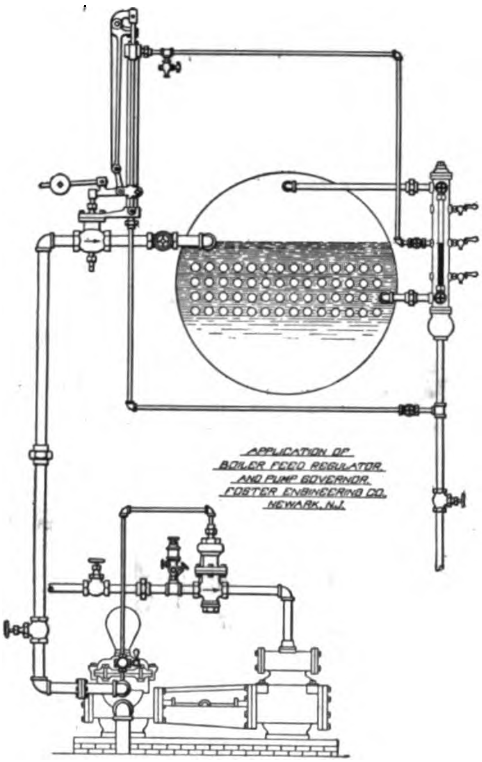
"An installation using condensation in the lower group of tubes, supplemented by live steam in the upper group of tubes, was recently made in the new Commerce Building in Erie, Pa., with very satisfactory results. The condensate leaves the tubes at

a temperature of about 70 degrees to 80 degrees F. and very little live steam is required to maintain a temperature of 125 degrees to 135 degrees F. steadily."

Trade Literature.

Foster Automatic Feed Water Regulator, announced as the latest scientific production of the Foster Engineering Co., Newark, N. J., is illustrated and described in a circular just issued by the manufacturers. The appliance is fully guaranteed to maintain water at the predetermined height, regardless of quantity or qualty of coal used; to insure against flooding or "low water"; to aid in increasing the steaming power and prolonging the life of the boiler. It is also described as thoroughly automatic. Its operation is as follows: Normally the water in the boiler or water column seals the end of the pipe leading to the top of the expansion tube, so that steam is excluded therefrom and the tube is cool or contracted. In this condition of the expansion tube the long arm of the bell crank lever "8" is free to swing outward from the expansion tube and allows the weight to depress the arm of the lower bell crank "10," so as to slide valve "14" downward into closed position, cutting off and preventing water from entering the boiler through feed line. When the water recedes below the predetermined boiler level it uncovers the opening in the pipe leading from the water column to the top of the expansion tube and permits steam to enter the same. This heats and expands tube "1," carrying the adjusting screw "9," which can be set for any desired variation, upward against the short arm of bell crank lever "8," thus swinging the long arm of the latter inwards or towards the expansion tube. This carries the lower bell crank lever "10" and raises the weight, drawing valve "14" upward, opening the main feed valve, permitting water to flow through the feed pipe into the boiler. The flow continues until steam is again cut off from the expansion tube "1," allowing the contraction of the latter sufficiently to close valve "14."

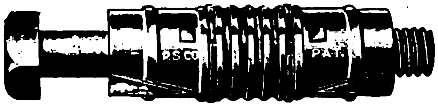

FOSTER BOILER FEED REGULATOR AND PUMP GOVERNOR.



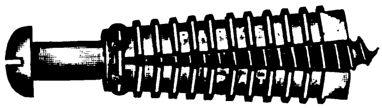
APPLICATION OF FOSTER BOILER FEED REGULATOR AND PUMP GOVERNOR.

Parker Expansion Bolts, featured as the only expansion bolts which cannot turn in the hole, are described in new circular matter as the latest product of the Parker Supply Co., 518 West 45th Street, New York. They are made in three types, the lag screw type, made of malleable iron; the machine bolt type, also made of malleable iron; and the crew screw anchor, made of composition metal. In the lag screw type, the reversibly directed projections, which, it is stated, are to be found only on Parker expansion shields, are described as the greatest single improvement yet made on expansion bolts, as they prevent the shield from turning in the hole. The steel

Lag Screw Type



Machine Bolt Type



Screw Anchor

PARKER EXPANSION BOLTS.

spring band of this type, allowing free and full expansion, is also to be noted. The machine bolt type of expansion bolt has interlocking nuts with little pins on the outside which lock into openings in the shield, preventing the shield from coming apart. They also have a ribbed surface. In the screw anchor type, the ends are made extra heavy and they also have breakable connections to prevent the anchor from taking a corkscrew twist.

LAGONDA BOILER ROOM SPECIALTIES, published by the Lagonda Mfg. Co., Springfield, O., illustrates this company's several types of boiler tube cleaners, with latest improvements, and boiler quick repair tools. It also covers the company's line of automatic cut-off valves and multiple strainers. Size 3½x6 in. (standard). Pp. 16.

ADVERTISERS' INDEX

*Every other month.

THE HEATING AND VENTILATING MAGAZINE

1123 Broadway — NEW YORK — July, 1915

Operating Data in Connection With Federal Buildings Under Control of the Treasury Department.

By Nelson S. Thompson.

Chief Mechanical and Electrical Engineer, Office of the Supervising Architect, Washington, D. C.

There are few engineers who have jurisdiction over the design, construction, and operation of mechanical and electrical equipment of buildings. This lack of intimate contact with the actual operating side of plants is a severe handicap to those who are not so fortunate, especially when engineers are called in to defend their recommendations for the installation of isolated power plants for buildings or industrial establishments. Their information on the subject of plant operation is purely theoretical and they have no bona fide records of their own to back up their calculations.

It is also true that only a few operating engineers are provided with means for accurately determining the coal and current consumption rates of the apparatus under their charge. The great majority are densely ignorant regarding the distribution of the steam generated in the boilers to the different portions of the equipment; i. e., the electric generating plant, the heating apparatus, etc., and consequently they have no records to produce, and have only a hazy idea of the situation when confronted by a good contract agent from the central station in an argument for or against shutting down the electric generating plants under their charge.

The office of the Supervising Architect is particularly fortunate in that it has exclusive jurisdiction over the design, construction, repair, and operation of the various buildings that it erects, and also has exclusive jurisdiction over the personnel of the operating forces, as well as over the purchase and use of all the supplies, etc., required for the various buildings. That this situation is correct and logical is borne out by the extraordinary economies that have been effected since steps were taken to place all these responsibilities under one technical bureau instead of entrusting them to several related or non-related bureaus, as was previously the custom in the Treasury Department, and as is still the custom in connection with school buildings, etc., in various cities in this country.

In order to obtain data upon the operation of Federal buildings under control of the Treasury Department, records are kept in some detail, especially in the larger buildings, and these records and data are studied, compared, and used as guides in the design of new projects.

All of the important buildings containing electric generating plants are equipped with coal scales, steam flow meters, water flow meters, CO_2 recorders, etc., and the chief operating engineers are provided with daily report blanks covering the coal consumption, ash removal, steam consumption of electric generating plants, etc. A few samples of the actual monthly reports follow:

CHIEF ENGINEER'S MONTHLY REPORT.

U. S. C. H. & POST OFFICE BUILDING AT BALTIMORE, MD. MONTH OF DECEMBER, 1914

Fuel	$189\frac{1716}{2240}$	Tons of coal,	at $3.35 per ton	$635 72
Water (make up water for boilers)	7,884	Cubic feet,	at $0.65 per 1,000 cubic feet	5 12
Ashes removed	26	Cubic yards,	at $0.50 per cubic yard	13 00
Boiler compound	15	Gallons,	at 100 cents per gallon	15 00
Cylinder oil	1	Gallon,	at 22½ cents per gallon	23
Engine oil	8	Gallons,	at 22 cents per gallon	1 76
Vacuum oil	2	Gallons,	at 23 cents per gallon	46
Gargoyle oil	21	Gallons,	at 23 cents per gallon	4 83
Waste	20	Pounds,	at 10 cents per pound	2 00
Cost of supplies for generating plant, packing tools, etc.				....
Cost of labor for entire plant				942 41
Cost of repairs to engines, dynamos, and switchboard authorized during month				....
Cost of repairs to boiler plant authorized during month				....
			Total	$1,620 53

SHERLOCK SWAN, Custodian (over.) H. W. ZOLLINGER, Chief Engineer

(Reverse Side.)

Cost of betterments to engines, dynamos, and switchboard authorized during month .... $

Cost of betterments to boiler plant authorized during month 30 09

	Av'g voltage	Av'g amp.	Max. amp.	Min. amp.	K. W. H.
(1) Lighting	......	......	......	......	......
(2) Power	......	......	......	......	......
(3) Light and power	240	424	800	200	39,088

Note—Where separate meters are installed fill in lines Nos. 1 and 2. Where only one meter is installed fill in line No. 3.

Average steam pressure .... 110 lbs. Water evaporated per pound of coal fired .... 10 lbs.

Average temperature feed water .... 208 degrees Steam consumed per K. W. H. in generating plant ...... 45 lbs.

Degree hours during month in which temperature is below 70 degrees ... 27,216. Live steam used in heating apparatus .... 672 hours.

Steam consumed by			Remarks:
Generating plant	1,758,960	lbs.	
Elevator equipment (hydraulic)	....	lbs.	
Auxiliary equipment (approximate)	500,000	lbs.	
Heating and condensation	2,482,407	lbs.	
Water actually evaporated	4,741,367	lbs.	
Water consumed in blowing off boilers	110,980	lbs.	
Water fed to boilers (meter readings)	4,852,347	lbs.	

CHIEF ENGINEER'S MONTHLY REPORT.

U. S. CHICAGO POST OFFICE BUILDING AT CHICAGO, ILLINOIS. MONTH OF FEBRUARY, 1915.

Fuel	672,690	Tons of coal,	at $3.02 per ton	$2,031 52
Fuel		Cubic ft. of gas, tons of screenings	at ...... per 1,000 cubic feet; ton	......
Water (make up water for boilers)	78,187	Cubic feet,	at .46875 per 1,000 cubic feet	36 65
Ashes removed	120¾	Cubic yards,	at .37 per cubic yard	44 68
Boiler compound	56	Pounds,	at .0136 cents per pound	76
Cylinder oil	26	Gallons,	at 25 cents per gallon	6 50
Engine oil	6	Gallons,	at 19 cents per gallon	1 14
Dynamo oil	...	Gallons,	at ...... per gallon	......
Crank-case oil	...	Gallons,	at ...... per gallon	......
Waste	...	Pounds,	at ...... per pound	......
Cost of supplies for generating plant, packing tools, etc., 54 Gal. Cyl. Oil—46½ Gal. Eng. Oil				22 33
Cost of labor for entire plant				1,971 65
Cost of repairs to engines, dynamos and switchboard authorized during month				......
Cost of repairs to boiler plant authorized during month; Misc. Supplies				250 00
			Total	4,365 23

.... Custodian. .... Chief Engineer.

(Over.)

(Reverse Side.)

Cost of betterments to engines, dynamos and switchboards authorized during month .... $......

Cost of betterments to boiler plant authorized during month ....

	Av'g voltage	Av'g amp.	Max. amp.	Min. amp.	K. W. H.
(1) Lighting	115	1,079	1,950	400	83,400
(2) Power	230	325	420	100	31,160
(3) Light and power	......	......	......	Total	114,560

Note—Where separate meters are installed fill in lines Nos. 1 and 2. Where only one meter is installed fill in Line No. 3.

Average steam pressure .... 152 lbs. Water Evaporated per pound of coal fired .... 9.667 lbs.

Average temperature feed water .... 180.1 degrees. Steam consumed per K. W. H. in generating plant ..... 48.1 lbs.

Degree hours during month in which temperature is below 70 degrees .. 23,078 Live steam used in heating apparatus .. 197 hours

Steam consumed by		
Generating plant	5,519,299	lbs.
Elevator equipment (hydraulic)	2,221,622	lbs.
Auxiliary equipment (approximate)	5,368,602	lbs.
Pneumatic tube engines	1,457,394	lbs.
Water actually evaporated	14,566,917	lbs.
Water consumed in blowing off boilers	93,296	lbs.
Water fed to boilers (meter readings)	14,660,213	lbs.

Remarks:

Total Expense for Month of—	
February, 1914	$6,685 70
February, 1915	4,365 23
Saving for month	$2,320 47
Total saving for year	$15,984 78

CHIEF ENGINEER'S MONTHLY REPORT.

U. S. CUSTOM HOUSE BUILDING AT CINCINNATI, OHIO. MONTH OF DECEMBER, 1914.

Fuel	100,739	Tons of coal,	at $3.19	per ton	$321 36
Fuel	4,880,000	Cu. ft. of gas,	at .131412	per 1,000 cubic feet	641 29
Water (make up water for boilers)	15,631	Cubic feet,	at .80	per 1,000 cubic feet	12 50
Ashes removed (20.6 cu. yds. on hand)			at	per ton or cubic yard	......
Boiler compound	12	Pounds,	at 8	cents per pound	96
Cylinder oil	43½	Gallons,	at 25	cents per gallon	10 88
Engine oil	46	Gallons,	at 19	cents per gallon	8 74
Dynamo oil	......	Gallons,	at ..	cents per gallon	......
Crank-case oil	......	Gallons,	at ..	cents per gallon	......
Waste	22	Pounds,	at 9¾	cents per pound	2 14
Cost of supplies for generating plant, packing tools, etc.					......
Cost of labor for entire plant					983 90
Cost of repairs to engines, dynamos and switchboard authorized during month					......
Cost of repairs to boiler plant authorized during month					......
			Total		$1,981 77

....Custodian. ....Chief Engineer.

(Over.)

(Reverse Side.)

Cost of betterments to engines, dynamos, and switchboard authorized during month; Separator and Trap authorized Oct. 10th.. $245 00

Cost of betterments to boiler plant authorized during month ....

(1) Lighting, av'g voltage.... 115 Av'g amp..... 413.5 Max. amp.. 610.97 Min. amp.. 263.22 K. W. H.. 35,390

(2) Power, av'g voltage .... 115 Av'g amp..... 146.45 Max. amp.. 388.06 Min. amp.. 72.9 K. W. H.. 12,540

(3) Light and power, av'g voltage ... Av'g amp..... ..... Max. amp.. ..... Min. amp.. ..... K. W. H.. .....

Note—Where separate meters are installed fill in lines Nos. 1 and 2. Where only one meter is installed fill in Line No. 3.

Average steam pressure .... 107 lbs. Water evaporated per pound of coal fired........... 8 lbs. Water evaporated per cu. ft. of gas fired.......... .82 lb.

Average temperature feed water............... 202.13 degrees. Steam consumed per K. W. H. in generating plant...... 41.412 lbs.

Degree hours during month in which temperature is below 70 degrees...29,568 Live steam used in heating apparatus... 744 hours

Steam consumed by	Generating plant	1,985,078 lbs.	Remarks:
	Elevator equipment (hydraulic)	...... lbs.	
	Auxiliary equipment (approximate)	217,000 lbs.	
	Pneumatic tube engines	...... lbs.	
Water actually evaporated		5,806,840 lbs.	
Water consumed in blowing off boilers		230,678 lbs.	
Water fed to boilers (meter readings)		6,037,518 lbs.	

CHIEF ENGINEER'S MONTHLY REPORT.

U. S. POST OFFICE AND COURT HOUSE BUILDING AT SAN FRANCISCO, CAL. MONTH OF DECEMBER, 1914.

Fuel	28,790	Gallons of oil,	at $0.02164	per gallon	$621 86
Fuel, cubic feet of gas; tons of screenings			at	per 1,000 cubic feet; ton	......
Water (make up water for boilers)	19,664	Cubic feet,	at meter rate	per 1,000 cubic feet	46 34
Ashes removed	.....	Tons or cu. yds.,	at	per ton or cubic yard	......
Boiler compound	186	Pounds,	at 10	cents per pound	18 60
Cylinder oil	37	Gallons,	at 48	cents per gallon	17 76
Cup grease	6¾	Pounds,	at 15	cents per pound	1 01
Dynamo oil	3	Gallons,	at 35	cents per gallon	1 05
Crank-case oil	54	Gallons,	at 35	cents per gallon	18 90
Waste	28	Pounds,	at 9¾	cents per pound	2 73
Cost of supplies for generating plant, packing tools, etc. Packing Hyd. Elevators					4 00
Cost of labor for entire plant					745 66
Cost of repairs to engines, dynamos, and switchboard authorized during month					......
Cost of repairs to boiler plant authorized during month					......
			Total		$1,477 91

....Custodian. ....Chief Engineer.

(Over.)

(Reverse Side.)

Cost of betterments to engines, dynamos, and switchboard authorized during month .... $......

Cost of betterments to boiler plant authorized during month ....

(1) Lighting, av'g voltage......... 224 Av'g amp.. 310.7 Max. amp.. 450 Min. amp.. 100 K. W. H.. 51,767.0

(2) Power, av'g voltage.......... 224 Av'g amp.. 114.6 Max. amp.. 320 Min. amp.. 50 K. W. H.. 19,152.0

(3) Light and power, av'g voltage. ... Av'g amp.. ..... Max. amp.. ... Min. amp.. ... K. W. H.. 70,919.0

Note—Where separate meters are installed fill in lines Nos. 1 and 2. Where only one meter is installed fill in Line No. 3.

Average steam pressure...................... 125 lbs. Average temperature feed water.................. 230 degrees.

Water evaporated per pound of oil fired.............. 13.92 lbs. Steam consumed per K. W. H. in generating plant..... 41.1 lbs.

Degree hours during month in which temperature is below 70 degrees....15,912. Live steam used in heating apparatus....None.

Steam consumed by	Generating plant	2,916,129.1 lbs.	Remarks:
	Elevator equipment (hydraulic)	.... lbs.	
	Auxiliary equipment (approximate)	204,089.1 lbs.	
	Pneumatic tube engines	.... lbs.	
Water actually evaporated		3,120,218.2 lbs.	
Water consumed in blowing off boilers		40,185.6 lbs.	
Water fed to boilers (meter readings)		3,160,403.8 lbs.	

These monthly reports from the large buildings are turned over to one of the mechanical and electrical engineers of the office, who analyzes them, compares one with another, and calls to the attention of the chief mechanical and electrical engineer any matters that need attention.

Each year these monthly reports are tabulated for ready comparison, as illustrated by Table I.

DEPARTMENT NOT PREJUDICIAL AS REGARDS ISOLATED PLANTS AND CENTRAL STATIONS.

The department holds no brief for the isolated plant versus the large central plant, but analyzes each individual building on its merits and chooses the most economical course in the matter of supplying electricity and light.

To compete with the large central plants it is absolutely necessary to install engines and generators of the highest economy consistent with a reasonable first cost, and this has led to the adoption of the high-speed, non-release, Corliss type of four-valve engine with a low percentage of clearance and close regulation, because electric elevators are operated from the same bus-bars as the lighting system, and no flickering of the lamps is tolerated.

The engines and generators are purchased on the evaluation system, which means, in effect, that the government is willing to make a substantial investment in steam or current producing apparatus if it can be demonstrated by test that the savings per annum of the costly apparatus will pay a dividend of 13% on the additional investment which is always required when the first cost of an economical steam engine is compared with the first cost of an engine that is not economical and is marketed and exploited merely as an engine.

With the foregoing data at hand the actual cost of operating the electric generating plant in a building is known at once, and the question of purchasing current and shutting down the plant can be discussed intelligently. It may be stated in passing that the actual cost records are very disconcerting to the central station solicitor, who generally proceeds to assign values to steam consumption of engines, water evaporating capacity off boilers, etc., with considerable disregard of the facts as found in Federal buildings.

COST OF LABOR OFTEN A DETERMINING FACTOR.

It will be noted that the cost of labor in connection with the buildings given above as examples is very high as compared with the cost of labor in commercial plants, and it is worthy of note that by careful operation and close supervision it has been possible to compete with the large central stations except where certain influences have made the labor item outrageously excessive. In the plants which have been shut down in recent years the cause of the change has been that the engineering employees have over-reached themselves in the matter of hours of labor, rates of pay, etc., coupled with the fact that the plants themselves were old and generally low in all-around efficiency.

The central stations are each year making lower rates and approaching the point where the cost of purchasing current will be equal to or less than the cost of operating the isolated plants, and it behooves those interested in the maintenance of an isolated plant to keep up to date and effect every possible economy.

Table II. is introduced to give an idea of the annual consumption of electricity for power and light in certain large and small Federal buildings. It is interesting to compare the current consumption in Federal buildings (which are 24-hour buildings) with commercial buildings as reported by the Wisconsin Public Service Commission:

Class of building.	K.W.H. per annum per K.W. of full connected load (lighting only).
Churches	101
Farms	183
Laundries	185
Lodge halls	194
Schools	236
Residences	239
Theaters	367

* Since the preparation of the foregoing table the electric generating plants in Brooklyn and New York City have been shut down, and current is now purchased from the Edison Company, with the result of an annual saving in Brooklyn of approximately $8,000 per year, and in New York City of approximately $12,000 per year.

Offices	400
Livery stables	402
Stores	471
Hotels	505
Signs	551
Bowling alleys	809
Depots	937
Saloons	955
Industrial establishments	1,069
Restaurants	2,209

Federal buildings.	K.W.H. per annum per K.W. full connected lighting load.	K.W.H. per annum per H.P. of full connected power load.
Small buildings up to 250,000 cubic contents.	1,200	*350
250,000 to 500,000 cubic contents	1,200	160
500,000 to 1,000,000 cubic contents	1,200	200
1,000,000 to 10,000,000 cubic contents	3,300	400

* All stamp canceling machines.

The foregoing data are extremely valuable in estimating the operating characteristics of a new building which is being designed, at which time it is essential that the maximum demand, full connected load, annual K. W. H. consumption, heating requirements, labor force, etc., be accurately determined, in order that an intelligent comparison may be made with the rates quoted by the local electric company to see whether the installation of an isolated electric light plant would be justified.

It may be stated roughly that the full connected power and lighting load will not exceed 1½ watts per square foot of floor space of the entire building; that the maximum demand will not exceed 50% of the full connected lighting and power load; and that the electric current consumption per annum for power and light will not exceed 2 K. W. H. per square foot of floor area in a modern building with ample and well-placed windows.

WHEN ISOLATED PLANTS ARE PREFERABLE.

Generally speaking, an isolated plant begins to be feasible in a Federal building where the full connected load is 150 K. W. or more, and where the annual current consumption is 200,000 K. W. H. or more per annum and the cost of current from the central station exceeds 4 cents per K. W. H.

In commercial buildings, an authority states that in and around New York City where the cost of purchased current will approximate 5 cents per K. W. H. an isolated plant should be given consideration when the annual current consumption is 60,000 K. W. H. or more.

A leading mechanical and electrical engineer of New York City has stated that in a given building where there are two or more electric elevators and 1,000 or more lighting sockets (50-watt rating) an isolated plant becomes a possibility when the cost of purchased current is 5 cents per K. W. H. or greater.

(In the August issue Mr. Thompson will present another interesting table of operating statistics for a number of Federal buildings in Washington, D. C., supplemented by an account of the procedure followed in a city which has a central heating plant.)

Space Requirements for Boilers of Various Types in School Buildings

By T. W. Reynolds.

In the consideration of space requirements for ventilation plants in school buildings, one of the most important items is that involving the space or cubic contents allotted to the boilers. As the cost of such buildings is usually estimated at so much per cubic foot, the importance of boiler selection, in its relation to the space required, may well be considered.

The following comparison of a well-known make of cast-iron sectional smokeless downdraft boiler (set either singly or in duplicate with space between), with an equally well-known make of brick set smokeless downdraft firebox boiler having an equal rating (set singly, in battery or in two units with space between), is interesting when the practical merits of the boilers are considered, aside from other issues.

The overall outlines of the boilers are

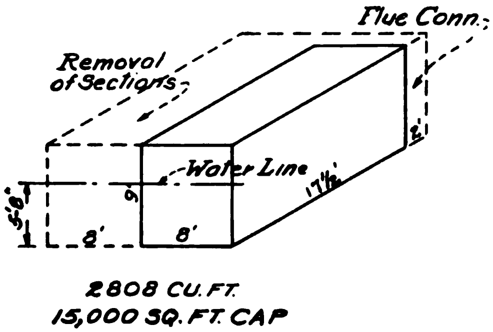


FIG. 1—TYPICAL INSTALLATION OF SECTIONAL CAST-IRON BOILER.

shown in full lines with dotted lines denoting the necessary space required for the flue connection and for the removal of boiler sections as in the sectional boiler, also the removal of water grate bars and withdrawal of tubes as peculiar to the steel boiler.

A comparison of the water line in each make of boiler is equally interesting for the returns of a gravity steam heating system must necessarily be 18 in. or preferably 3 ft. higher than the water line in the boiler. This may mean more or less excavation for the depression of the boiler room floor, with a corresponding increased cost according to local conditions.

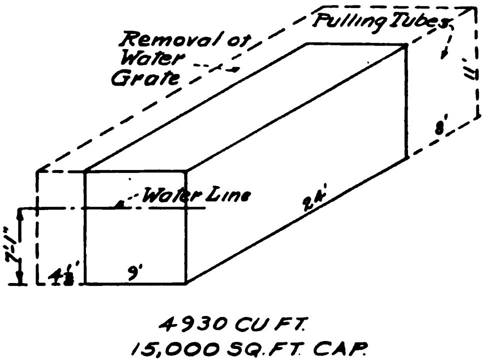


FIG. 2—TYPICAL INSTALLATION OF SINGLE STEEL BOILER.

The use of the cast-iron boiler is precluded when high steam pressures are required, but where low pressure heating systems are installed it may well be used, as the cost is less.

Referring to the sketches, Fig. 1 represents a single cast-iron boiler having a capacity equivalent to 15,000 sq. ft. of direct radiation, the largest of this type made. Where head room is not available or interference with overhead steam piping is to be avoided, the removal of sections for repairs cannot be affected by lifting upwards, but they must be withdrawn from either side as shown by the clear space of 8 ft. For the proper connection of boiler to flue, with provision for damper operation, an additional 2 ft. must be provided at the rear. Note the total cubic contents of 2,808 cu. ft., and the water line of 5ft. 8 in. The water grate is so arranged that it may

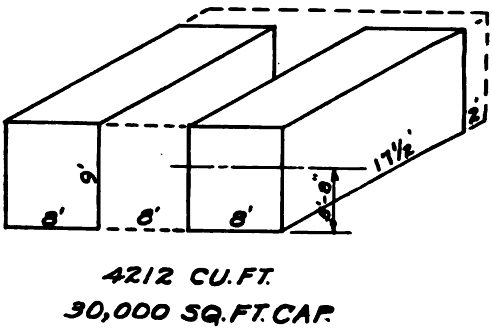


FIG. 3—SPACE REQUIREMENTS FOR TWO CAST-IRON BOILERS.

easily be removed through the firing doors.

In direct comparison refer to Fig. 2. typical of a single steel boiler having an equal capacity. For the removal of the bar in the water grate 4½ ft. at the left hand side is required, while the withdrawal of tubes requires an additional 8 ft. at the rear. The total cubic feet required is 4,930, while the water line is 7 ft. 1 in. The tubes cannot be with-

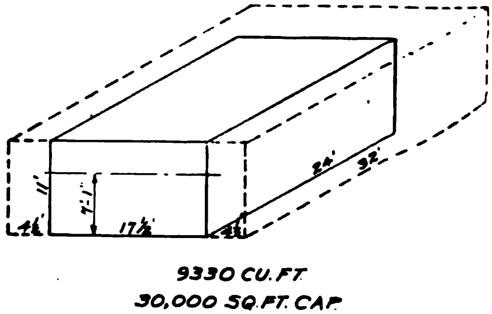


FIG. 4—SPACE REQUIREMENTS FOR TWO STEEL BOILERS.

BUILDING		BALT P.O. &	PHILADELPHIA CH. & P.O.	PITTSBURG P.O.	SAN FRANCISCO P.O. & CT. H.	ST. LOUIS CU. H.	ST. LOUIS NEW P.O.	TOTALS
BOILERS	NO.		5.	4.	5.	5	4	92.
	H.P.		600.	480.	650.	1,000.	600.	14,069.
GEN'S	NO.		4.	3.	4.	4.	—	49.
	HP ENG.		750.	495.	720.	400.	—	7,342.
	KW. GEN.		475.	300.	450.	250	—	4,643.
MISC. ENG.	NO.		—	—	—	—	—	15.
	HP		—	—	—	—	—	290.
STEAM PUMPS	NO.		3.	2.	6.	1.	3.	89.
	HP		25.	10.	18.	5.	40.	2,130.
STEAM ELEV	NO.		—	—	—	—	—	15.
	HP		—	—	—	—	—	675.
HEATING SURFACE SQ. FT.	DIR. RAD	20	12,891.	16,480.	9,980.	47,500.	12,047.	460,606.
	IND. RAD		8000.	2,816	3,530.	9000.	10,350.	122,608.
	EQUIV. DIR.	20	6,891.	24,928.	20,570.	74,500.	43,097.	819,050.
	SYSTEM	St	Steam.	Steam	Steam	Hot Water	Steam.	—
ELECTRIC POWER K.W.	ELEV. MO.		108.	55.	117.	66.	12.	1,184.
	PUMP "		28.	—	33.	6.	25.	410.
	MISC. "		56.	12.	150.	24.	308.	1,738.
	COND. LOAD		192.	67.	300.	96.	345.	3,332.
	MAX. DEM.		60.	40.	94.	55.	70.	1,163.
	MIN. "		10.	5.	5.	0.	4.	62.
ELECTRIC LIGHTING K.W.	LIGHTING		140.	125.	158.	116.	130.	2,232.
	MISC.		4.	5.	7.	10.	20.	213.
	COND. LOAD		144.	130.	165.	126	150.	2,445.
	MAX. DEM.		116.	60.	135.	82.	94.	1,683.
	MIN. "		50.	10.	17.	22.	19.	353.
ELECTRIC CURRENT K.W.	COND. LOAD		336.	197.	465.	222.	495.	5,777.
	MAX. DEM.		140.	92.	212.	130	141.	2,516.
	MIN. "		60.	15.	22	22	23	422.
	ANNUAL K.W.H.	367,	700,441.	317,322.	659,203.	383,761.	512,232.	8,649,821.
	AVER. DEM.		80.	36.2	75.3	43.8	58.5	985.
CONTENTS, CU. FT.		P.O. 3,68 Custom H. 2,0	378,900.	3,276,000.	4,166,500.	5,885,000.	4,769,500.	99,466,500.
FLOOR AREA SQ. FT.		P.O. 15 Customs 15	204,700.	126,000.	216,500.	161,500.	167,200.	4,294,400.
CURRENT COST		—	—	—	—	—	9,271.61	[illegible]
COAL	TONS	1,37	3,627.98	39,374,200. cu ft gas	329,073 gal. oil	2,879.723	1,162.779	[illegible]
	COST	4,3	8,780.45	6,094.57	6,243.19	6,093.71	2,397.06	147,634.75
WATER	CU. FT.	41,6	87,409.	391,098.	295,645.	390,450.	4,861.	9,885,542.53
	COST		146.22	347.68	667.17	234.27	4.74	8,709.18
ASH REMOVAL	CU. YDS.	2	1,432.17	—	—	1,053.8	279.54	14,918.88
	COST	/	535.66	—	—	415.62	113.39	5,946.40
OIL	GALLONS	3	631.5	816.5	849.625	521.	33.55	17,629.145
	COST	/	143.35	192.82	344.98	99.33	7.93	3,907.00
WASTE	POUNDS	3	1,464.	190.	279.5	462	92.	11,622.875
	COST		98.82	17.10	27.95	42.65	8.28	1,067.19
OTHER SUPPLIES			113.75	46.09	297.00	38.50	37.00	4,423.58
REP. TO GEN. PLANT		1	10.91	0.00	48.00	0.00	0.00	4,968.59
REP. TO BOILERS		3	140.57	51.00	361.00	491.42	52.50	8,720.29
LABOR		12,21	18,437.50	7,963.75	13,385.00	16,570.00	9,671.25	259,029.38
TOTAL COST		17,07	28,407.23	14,713.01	21,374.29	23,985.50	21,563.76	471,848.70
ENGINEERING PERSONELL		1 Chief En 3 Ass't Eng 1 Eng. Helper @ 1 Electrician @ 3 Fireman @ 1 Fmn Helper 2 Coal Passers	Eng @ 2000.00 t Eng @ 1200.00 Help @ 1000.00 ectrician @ 1200.00 reman @ 2.50 pd n Help @ 2.25 pd lgrs @ 840.00	1 Ch Eng @ 1600.00 3 Ass't Eng @ 1000.00 1 Eng Helper @ 900.00 3 Fireman @ 2.25 pd	1 Ch. Eng @ 2000.00 3 Ass't Eng @ 1200.00 3 Electricians @ 1000.00 1 Elec Mech. @ 1500.00 4 Fireman @ 2.25 pd	1 Ch Eng @ 2200.00 3 Ass't Eng @ 1200.00 3 Eng Help @ 1000.00 1 Electrician @ 1300.00 3 Fireman @ 2.50 pd 2 Fmn Help @ 2.25 pd 2 Coal Psrs @ 2.00 pd	1 Ch Eng @ 1600.00 1 1st Ass't Eng @ 1400.00 1 Ass't Eng @ 1200.00 1 Eng Help @ 1000.00 1 Fireman @ 2.50 pd 1 Fmn Help @ 2.25 pd 5 Fireman @ 2.25 pd	91 [illegible] 114,100.00 11 Dyn tenders and Oilers 10,935.00 22 Elec. 24,100.00 128 Boiler Rm Engineers 109,089.38
COST ELECTRICITY/KWH WITHOUT INT. & DEPR.		.01	.0159	.013	.0081	.0204	.0181	[illegible]
COST STEAM/1000# WITHOUT INT. & DEPR.		.3	.269	.223	.293	.311	.372	.311
POWER & LIGHT PER CU. FT.		.00	.00151	.00126	.00128	.00133	.00195	.00141
HEATING PER CU. FT.		.00	.00234	.00323	.00385	.00212	.00260	.00300
TOTAL COST " " "		.00	.00385	.00449	.00513	.00345	.00455	.00441
POWER & LT. PER SQ. FT.		.01	.0545	.0328	.0246	.0485	.0654	.03252
HEATING PER SQ. FT.		.07	.0843	.084	.0741	.0772	.0742	.06952
TOTAL COST " " "		.09	.1388	.1168	.0987	.1257	.1296	.10204

$3,688.42 STEAM SOLD TO P. TUBES

Supplement to The

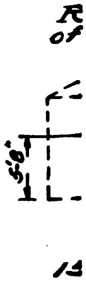


FIG. 1

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BUILDIN NAME	K.W. d load Day	POWER Motor H.P. Connected	K.W. Demand	K.W.H. per Annum	K.W.H./H.P. per Annum	K.W.H./K.W. connected ld. per An.	TOTAL LIGHT AND POWER K.W. Demand	K.W.H./K.W. connected ld. per An.
Chicago	9.1	925	140	335,000	362	487	420	1,466
Cincinnat	8,0	188	51	109,000	580	780	107	1,770
Philadelph	10.7	257	60	130,000	506	678	140	2,080
New York,	10.2	625	180	343,000	549	735	367	1,820
St. Louis,	7.8	128	55	24,000	187	250	130	1,740
Buffalo	6.0	188	50	9,500	50	68	100	925
AVERA	9.0	385	89	158,400	412	550	211	1,625
Jacksonvill	5.0	25		9,260	370	497		1250
Topeka,	3.0	20		1,560	78	96		670
St. Joseph,	2.5	17		2,223	135	175		575
Cedar Rapid	2.8	20		1,349	68	90		662
Ft. Worth,	5.0	38		11,250	300	396		795
Chattanooga,	7.0	16		2,640	162	222		1340
San Antonio,	2.3	16		4,129	258	347		653
Mobile Al	5.3	17		3,530	202	278		1117
Galveston,	4.9	16		4,030	250	338		1020
Wheeling,	3.6	33		3,847	117	156		685
Peoria,	1.9	20		3,142	157	210		562
AVERA	3.5	21.64		4,271	197	265		810
Columbia,	2.7							975
Rock Islan	2.7	30		2,400	80	107		413
Ft. Dodge,	1.1							402
Lexington	5.6							2050
Boise, Ida	2.3	20		2,776	139	186		500
Harrisburg	4.0	1.5		3,027	200	270		921
Pensacola,	4.3	15		2,205	157	197		765
Jackson,	3.9	2½		1,563	625	837		1320
Greensboro,	7.4	½ *		385	770	1030		2600
Leavenwort	6.3	½ *		95	190	254		2170
Fargo, N.D.	3.1	16		781	56	66		505
Asheville,	1.6							635
Burlington	1.7	20		120	6	8		277
AVERAG	3.5	9.2		1027	112	227		800
Kokomo,	1.9							690
Petersbur	2.3							846
Pine Bluff,	4.4	½*		168	338	450		1530
Ithica, N.	3.0							1080
Bloomington	6.7							2490
New Albany,	5.1							1840
Athens,	2.8							1010
Monroe,	2.3							850
Meadville,	2.4							865
Muncie,	4.3	⅓*		126	378	506		1480
AVERAG	3.2	.083		29.4	354	474		1173

* Cancelling Machine Motor

drawn from the front without removing the water grate and brick fire stop arch. The brick set boiler is preferable to the portable type, the latter having a front flue connection necessitating interference of the breeching with overhead steam piping. This is avoided in the brick set because of the rear flue connection.

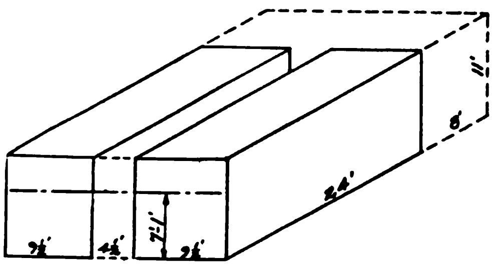


FIG. 5—ALTERNATIVE ARRANGEMENT FOR TWO STEEL BOILERS.

Referring to Fig. 3, two cast-iron boilers are shown each having a capacity of 15,000 sq. ft. with an 8 ft. space between for the removal of sections and a 2 ft. space at the rear for the flue connection. Total cubic feet, 4,212. Water line, 5 ft. 8 in., as before.

For comparison of the above, two methods of installation for the steel boiler are shown as in Figs. 4 and 5. In Fig. 4, two boilers, each having a capacity of 15,000 sq. ft., are set in battery. A clear space of 4½ ft. at each side is required for the removal of the water grate bars with an 8 ft. space at the rear for the drawing of tubes. Total cubic feet, 9,330. Water line, 7 ft. 1 in.

In Fig. 5 two boilers having a total capacity of 30,000 sq. ft. are set with a space between them of 4½ ft. for the removal of the bars in the water grate. As before, an 8 ft. space at the rear is necessary for drawing tubes. Total cubic feet required, 8,270. Water line, 7 ft. 1 in.

The Establishment of a Standard for Transmission Losses From Buildings of all Constructions

By Reginald Pelham Bolton.

(*From report of the Educational Committee, presented before the National District Heating Association, Chicago, June* 1-3, 1915.)

At first sight this subject appears to be, at the present time, somewhat elementary. Common practice has accepted results of certain experimental tests as determining the transmission of heat through building materials.

The pioneer work of Péclet in this direction has been followed by experiments conducted under the auspices of the German and French governments, and some individual work has been effected by other observers. The subject has long been presented in standard works such as those of Box and Carpenter, and in technical papers and pamphlets by Doctors Kinealy, Allen and Carpenter, by Messrs. Hubbard, Hogan, Wolff and Harding.

But, as Dr. James Hoffman says, "many of the values are only rough approximations at best." The various test results were compared by this author, who found quite a divergence between the references and prepared a table representing "a fair average" of all of them. These disagreements indicate that the matter is by no means conclusively decided. There are to begin with great variations in the character of the materials which are classed under a single description.

A "brick wall" may be of very variable materials in different localities, and "frame construction" may vary very largely in form as well as in workmanship.

But apart from these explainable divergencies, there is by no means a positive determination as to whether the rate of transmission is the same for a small difference as for a large difference of temperatures. This is a funda-

mental element which calls for definite determination. The rate of heat transmission should, theoretically, be in proportion to the difference of temperature between one surface and another, and this is the generally accepted assumption.

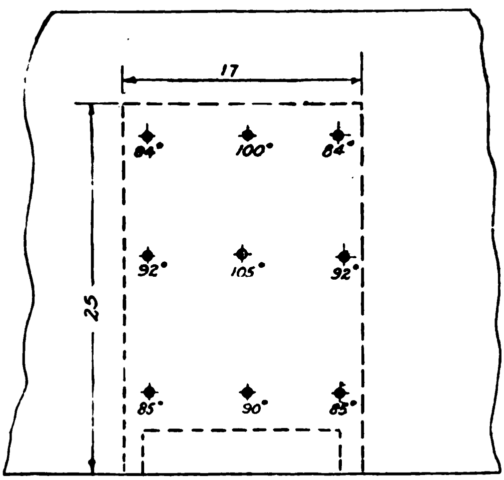
It may be nearly or wholly correct for materials of a homogeneous character, such as metal, but there is at least a probability that the rate may vary through composite materials, and through those offering a high extent of resistance to heat transfer.

In such materials it would seem possible that the rate of transfer would fall off materially at low differences between opposite sides of the material. If this is the case, it may account for some of the divergence between results observed in different experiments. This part of the subject is therefore still open to further investigation.

There are three forms of heat transfer through building materials, viz.: radiation, convection and conduction. The common acceptance of the term radiator or of the action of radiation as applied to heat transfer, needs correction. The term is a misnomer as applied to heating apparatus commonly known as a "radiator," since the heat radiated from such low temperature surfaces is a minor part of the work of heat transfer which they effect. They should be more properly termed "convectors," since by means of air-motion over their surfaces and physical transmission of heat by contact with it, they effect the major part of their work.

Available information upon the subject of radiated heat, its laws, its methods and its comparative effects, is extremely deficient.

We hardly know whether the transfer of energy which takes this form is really heat or is heat transformed to energy, which is retransformed to heat in the body or surface upon which it impinges or through which it passes. But whatever be its character or extent, such as it is, it is largely wasted in our present methods of installing heating apparatus. The modern method is to place "radiators" backing on an exterior wall, generally under a window.



The figures in area enclosed by dotted lines show temperatures in degrees Fahrenheit of the wall behind radiator

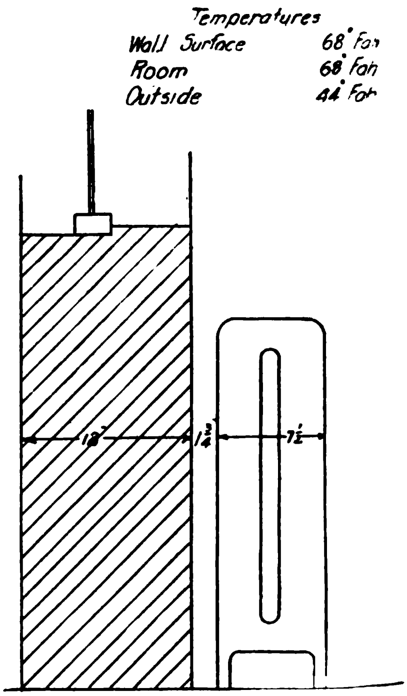


DIAGRAM ILLUSTRATING EFFECT OF PLACING RADIATORS CLOSE TO WALLS.

CONDUCTIVITY OF VARIOUS MATERIALS ENTERING INTO THE EXTERIOR CONSTRUCTION OF BUILDINGS, AS DETERMINED BY VARIOUS AUTHORITIES AND AUTHORS.

Materials		Heat units per degree difference per square foot							
Substance	Construction	Péclet (Carpenter)	German Government	Austrian Government (Macon)	Greene 1913	Recknagel and Reitschel	Carlton F. Tweed	Harding	Hoffman
Glass	single window	According to height (see note)	1.09	1.07	0.96	1.03	...	...	1.0
	single window (wet)		...	...	1.1	...	...	...	...
	single window (wire glass)		...	1.04	...	...	1.35	...	...
	double windows	...	0.418	0.47	0.41	.472	0.50	...	0.6
	single skylight	...	1.118	1.14	1.06	1.090	1.10	...	1.1
	double skylight	...	0.621	0.48	0.51	.492	0.60	...	0.7
Brick	wall, 8 in. thick	0.37	0.46	...	0.39	.37	0.39	...	0.4
	wall, 12 in. thick	0.32	0.32	...	0.31	.29	0.31	...	0.31
	wall, 16 in. thick	0.28	0.26	...	0.25	.25	0.25	...	0.26
	wall, 20 in. thick	0.25	0.23	...	0.21	.22	0.21	...	0.23
	wall, 24 in. thick	0.24	0.20	...	0.18	.19	0.18	...	0.21
	wall, 28 in. thick	0.22	0.174	...	0.16	.16	0.16	...	0.19
	wall, 32 in. thick	0.21	0.15	...	0.15	.14	0.15	...	0.17
Brick and Plaster	B. & P. 8½ in. thick	...	...	0.43	0.37	.36	...	0.5	...
	B. & P. 13 in. thick	...	...	0.43	0.29	.28	...	0.33	...
	B. & P. 17½ in. thick	...	...	0.29	0.24	.24	...	0.25	...
	B. & P. 22 in. thick	...	...	0.24	0.21	.21	...	0.21	...
	B. & P. 27½ in. thick	...	...	0.21	0.18	.18	...	0.17	...
Brick furred and plastered	B. F. & P. 8½ in. thick	...	...	...	0.24	...	0.24	0.41	0.28
	B. F. & P. 13 in. thick	...	...	...	0.20	...	0.20	0.3	0.217
	B. F. & P. 17½ in. thick	...	...	...	0.18	...	0.18	0.23	0.18
	B. F. & P. 22 in. thick	...	...	...	0.16	...	0.16	0.2	0.161
	B. F. & P. 26½ in. thick	...	...	...	0.14	...	0.14	0.16	0.147
Limestone	wall, 16 in thick	...	...	0.56	...	0.43	...	...	0.39
	wall, 20 in. thick	...	...	0.50	...	0.38	...	...	0.35
	wall, 24 in. thick	...	...	0.45	...	0.35	...	...	0.31
	wall, 28 in. thick	...	...	0.41	...	0.31	...	...	0.28
	wall, 32 in. thick	...	...	0.36	...	0.28	...	...	0.25
Sandstone	wall, 12 in. thick	...	...	0.58	...	0.45	0.28	...	...
	wall, 16 in. thick	...	...	0.51	...	0.39	...	...	...
	wall, 20 in. thick	...	...	0.45	...	0.35	...	...	...
	wall, 24 in. thick	...	...	0.41	...	0.31	0.23	...	...
	wall, 28 in. thick	...	...	0.37	...	0.28	...	...	...
	wall, 32 in. thick	...	...	0.31	...	0.26	0.19	...	...
Concrete	wall, 4 in. thick	...	...	...	...	...	...	1.07	...
	wall, 6 in. thick	...	...	...	...	...	...	0.7	...
	wall, 8 in. thick	...	...	0.49	...	...	...	0.53	...
	wall, 12 in. thick	...	...	0.43	0.48	...	...	0.36	...
	wall, 16 in. thick	...	...	0.37	...	...	...	0.26	...
Wood	clapboards	...	...	...	...	...	...	0.47	.3 av'ge
	clapboards, paper lined	...	...	...	...	...	...	0.34	
	clapboards, sheathed	...	...	...	0.31	...	...	0.3	
	clapboards, sheathed and paper lined	...	...	...	...	...	...	0.26	
	ditto, and brick plastered	...	...	...	0.20	...	0.25	0.21	...
								Donnelly	...
	concrete, cinder fill, 4 in.	...	...	...	...	...	0.6	...	...
	concrete, cinder fill, 6 in.	...	...	...	...	...	0.5	0.43	...
	slated sheathed	...	...	0.43	...	...	0.43	0.36	...
	tin sheathed	...	...	...	...	...	...	0.31	...
	shingle sheathed	...	...	...	...	...	...	0.29	...
	tar and gravel	...	...	...	...	...	...	0.29	...
	mill tar and gravel	...	...	...	...	...	...	0.2	...
	shingle roof sheathed	...	...	...	0.31	...	...	...	...
Doors		...	0.414	...	0.34	...	0.31	...	...
		...	...	...	0.55	.410	0.48	...	...
	hardwood, ¾ in.	...	...	0.69	...	...	...	...	...
	hardwood, 1 in.	...	...	0.63	...	...	...	...	...

hardwood, 1½ in.	...	...	0.53	...	...	...
hardwood, 2 in.	...	...	0.46	...	...	...

Note—Péclet gives rates of heat transmis sion through glass, according to heights, as follows:

Window Height	Transmission in B. T. U. per sq. ft. per degree difference per hour
3 ft. 3 in.	0.98
6 ft. 7 in.	0.945
10 ft. 0 in.	0.93
13 ft. 3 in.	0.92
16 ft. 3 in.	0.91

—Compiled by Reginald Pelham Bolton. April, 1915.

Whatever be the effect of radiation, one half of the heating element from which it is derived directs the rays to this wall, and not to the interior space required to be heated. The wasteful effect is increased by the action of convection, passing a column of warmed air between the "radiator" and the wall. The result is that the wall surface behind each radiator becomes heated to a temperature far in excess of that of the room or interior space and the transmission of heat through that part of the building construction or material is substantially accelerated.

Observations upon such an instance as that illustrated here, showed an average temperature of the wall surface of 90.7°, nearly doubling the difference between the mean exterior temperature and that part of the interior surface of the wall.

SUMMARY OF OBSERVATIONS UPON TEMPERATURES OF WALL SURFACES BEHIND RADIATORS.

Average seasonal difference — interior of room to exterior—70-44, 20° F.

Average temperature of wall behind radiator, 90.7° F.

Average temperature of wall surface of room, 68° F.

Heat transmission per hour through wall behind radiator at 0.33 B. T. U. per square foot per degree difference in temperature, 15.4 B. T. U. per square foot.

Heat transmission per hour through wall surface other than behind radiators (68-44) equal 24° difference at 0.33 B. T. U. per square foot per degree difference in temperature, 7.92 B. T. U. per square foot.

The rate of heat transmission per square foot through the walls behind radiators is approximately twice the rate through the other exposed wall surfaces of the room.

The second process of heat transfer is that with which the study of the transmission losses is chiefly concerned. The process of conduction is a flow of heat from one part to another physically communicated. It is probably accelerated, as the foregoing inquiry tends to show, by radiated energy passing into, and perhaps through the materials.

But the process of conduction in building materials evidently varies by several conditions of the structure affected. The solidity of the mass is one. A brick of a spongy character, having many air particles in its composition must resist the conduction of heat much more than one of semi-metallic nature, or of densely compressed material. So that "bricks" should be further defined, and we need to learn something more of the heat-conducting qualities of them and of other materials, such as woods, commonly used in buildings, before a standard can be set for the rate of heat conduction.

Perhaps, even more than the relative homogeneity of materials, their heat carrying capacity is affected by moisture. Water is a good conductor of heat compared to air, or to calcined substances, so that if a wall is water-soaked, its conductivity is thereby increased. Moreover, if its surfaces be wet, the transfer of heat from the surface to the air moving over the surface is bound to be accelerated.

It must not be forgotten that, in assuming a rate of heat transfer through building materials, the agent which imparts, and the agent which conveys away that heat may play a most important part. Hot moist air inside, with a damp wall surface should be an excellent agent to impart heat to a wall. So

also would be the effect in removal of heat of a wet wall and dry air outside.

Finally, the third element, convection, plays a large part in the rate of transmission of heat through wall and building surfaces. "Still air," inside or outside a building does not imply that even in the entire absence of wind movement, there is no movement of air upon the respective surfaces. Under such conditions an active motion is proceeding over both the surfaces, due to the acceleration of air movements by the dissipation of heat on the one side, resulting in a falling air current, and the reception of heat on the other, resulting in an upward air current.

The rate of these two motions must affect the rate of conduction of heat through the wall or other material. Such effects are well established in the process of heating water and in condensing steam. In such apparatus water is forced at high speed over heated surfaces greatly accelerating the heat transfer. We must suppose that very similar effects follow the action of quick air motion over building exteriors. But even with no wind, there is a lively upward motion of the enveloping layer of air around a building. The whole of the heat generated in a building has to find its way out through its surfaces, partly by leakage, but mainly by conduction. Every building, therefore, may be considered as a sort of "pyre," up the sides of which a column of heated vapor is whirling, rolling over on itself and joining a volume ascending from its windows and roof, which in still air ascends to some height before being fully absorbed into the aqueous atmosphere.

And it is not to be forgotten that each building may also be a large, though feeble, "radiator" directing low temperature rays of energy through surrounding spaces or into contiguous buildings.

From these considerations, it would seem that a vast amount of research, experiment and comparison remains to be done to decide the exact conditions of heat conduction through buildings, before the subject can be regarded as satisfactorily standardizable.

But as, in the meantime, and while this fascinating subject engages the further attention of the members of the heating profession, there must be some practical, approximate, or average data rendered available for our curent purposes; it may be of service to gather for our records and reference a compilation of the published results, which are, therefore, here presented for observation and use as judgment and experience may dictate.

Thoughtful consideration of some of the contingent elements to which attention has here been drawn will lead the student to apply to the use of these approximate determinations a cautious liberality by providing ample means of heating to cover possible deficiencies in the determinations of the rate of heat transfer through building materials.

Studies in Air Cleanliness

TESTS TO DETERMINE QUALITY OF CITY AIR WITH REGARD TO SUSPENDED IMPURITIES AND DISTRIBUTION OF IMPURITIES.

BY GEORGE C. WHIPPLE* AND MELVILLE C. WHIPPLE.

From a paper read at the annual meeting of the American Society of Heating and Ventilating Engineers, January 20-22, 1915.

Several series of experiments were made in Cambridge, Mass., during the past year for the purpose of studying the distribution of atmospheric dust in different districts of the city. The work was done at the instance of the Cambridge Sanitary Commission. The previous method of intermittent sampling of the air under different conditions was abandoned for one that registered the total precipitation of dust on a given surface over a period of several days. The advantage of the latter method is that it takes account of conditions dur-

*Professor of Sanitary Engineering Harvard University.

ing the twenty-four hours, and during any changes that occur from day to day. Any attempt to cover the same range by a count of dust particles in individual samples of air would involve an immense expenditure of time and effort.

METHOD OF COLLECTING DUST.

For collection of the dust two quart tin pails were used. These were coated with resistant varnish inside and out, about one liter of distilled water was placed in them, and they were suspended from the brackets on the poles of the Cambridge Electric Light Co. The height above the street varied from 20 to 21 ft. Later, when the varnish showed signs of cracking from exposure to air and water, glass jars were inserted in the pails to avoid any sources of error from the varnish or from corrosion of the pails.

The water served to retain any particles that settled out on its surface. About two weeks' exposure was allowed for each series of experiments and in this time evaporation did not exceed the liter of water originally placed in the pail. It averaged something less than 500 c.c. When the samples were brought into the laboratory the contents of the pails were carefully rinsed and each made up to one liter. Analyses were made of this water and the analyses when expressed in parts per million represented milligrams per liter, that is, total milligrams actually collected.

Various determination were made at the beginning of the work to obtain an idea of the amount of material collected, and it was found that the total solids obtained by evaporation of the water best represented this quantity, and it was considered that they supplied the most correct measure of suspended atmospheric impurities. Results for suspended solids in the water were not found to represent the suspended impurities on account of the solubility of portions of the atmospheric dust in the water in the pails. Filtration of the suspended solids showed effects of leaching, such as loss of color, and the filtrate was found to contain considerable traces of calcium, magnesium and chlorides.

Microscropical examinations were also made of a large number of samples but it was impossible to establish characteristic differences between them. The amount of agitation given the sample seriously affected the size of the particles which tended to agglomerate while in the pail. It was noticed by microscopical examination that the number of moulds increased greatly in the samples taken in the summer over those taken in the early spring.

Turbidity readings were taken on all samples and in the later work determinations were made of silica and iron.

SAMPLES DIVIDED INTO THREE SERIES.

For purposes of study all samples have been divided into three series, according to the particular time at which they were collected. Series I represents the period from April 2-14 inclusive, Series II, June 29-July 13, and Series III, July 31-August 14, 1914. All the arrangements for samples and analyses in connection with Series II and III were made by L. T. Fairhall of the Chemical Department at Harvard University.

In Table I is given a summary of weather conditions for the three periods. The first period was windy, the velocity reaching a high figure on two or three days. The winter's accumulation of street dirt was also being removed at this time. Series II and III were taken during normal summer weather, except for a considerable amount of rain during Series II.

TABLE I.—Amount of Rainfall and Wind Movement during Periods when Dust was Collected from the Air, Cambridge, Mass. (Compiled from Records of Boston Office of U. S. Weather Bureau).

Series Number	Date 1914	Rainfall in Inches	No. Days Rain fell	Total Miles Wind Movement	Maximum Wind Velocity, Miles per Hour
I	April 2-14	1.67	5	3469	47
II	June 29-July 13....	3.00	7	3091	25
III	July 31-August 14..	0.45	4	3195	22

The results of all total solids determinations have been arranged in order of magnitude and by series in Table II. The mean for each series is given, and also the calculated amount of solids in milligrams that would have fallen in one day upon a surface one square meter in area, and again in pounds per acre per day.

TABLE II.—Total Solids Collected at Different Times from Air in Cambridge, Mass.

Series I. April 2-14, 1914

Location of Sample	Total Solids in Milligrams	Total Solids Mg/Sq. Meter/Day	Total Solids Lbs./Acre/Day
Brattle St. and Sparks St..	184	1063	9.5
DeWolf St. and Cowperthwait St.	229	1322	11.8
Mt. Auburn St. and Hawthorne St.	252	1458	13.0
Garden St. and Concord Av	255	1472	13.1
Shepard St. and Garden St.	290	1680	14.9
Broadway and Dana St...	292	1690	15.0
Shepard St. and Walker St.	293	1696	15.1
Mass. Ave. and Waterhouse St.	303	1753	15.6
Brattle St. and Ash St.....	332	1920	17.1
Harvard St. and Dana St...	347	2005	17.8
Boylston St. at Power House	370	2141	19.0
Kirkland St. and Irving St.	374	2163	19.2
Cambridge St. and Kirkland St.	421	2430	21.6
Kirkland St. and Oxford St.	430	2483	22.0
Mass. Ave. and Arlington St	454	2622	23.2
Oxford St. at Pierce Hall..	497	2876	25.6
Putnam Ave. and Franklin St.	534	3085	27.4
Mass Ave. and Franklin St..	606	3510	31.2
Cambridge St. and Ellery St.	638	3690	32.8
Mass. Ave. East of Quincy Sq.	695	4020	35.8
Huron Ave. and Concord Ave.	951	5500	48.9
Mean	417	2409	21.4
Median	370	2141	19.0
Series II. June 29 to July 13, 1914			
Brattle St. and Feyerweather St.	102	506	4.5
Mt. Auburn St. and Maynard Pl.	125	621	5.5
Brattle St. and Ash St......	126	625	5.6
Brattle St. and Craigie St.	142	705	6.3
Brattle St. and Fresh Pond Parkway	150	744	6.6
Elmwood Ave. and Fresh Pond Parkway	150	744	6.6
Cambridge St. and Maple Ave.	165	819	7.3
Hampshire St. and Elm St.	174	863	7.7
Hampshire St. and Plymouth St.	177	878	7.8
Hampshire St. and Amory St.	182	903	8.0
Hampshire St. and Tremont St.	299	1483	13.2
Mechanics Square	892	4425	39.4
Mean	224	1110	9.9
Median	158	782	7.0
Series III. July 31 to August 14, 1914			
Arlington St. and Washington Ave.	47	297	2.6
Linnaean St. and Raymond St.	56	354	3.1
Magazine St. and Erie St....	61	386	3.4
Brattle St. and Hawthorne St.	73	462	4.1
Holmes Pl and Peabody St.	76	481	4.3
Quincy St. opp. Colonial Club	78	493	4.4
Garden St. and Appian Way	82	518	4.6
Mt. Auburn St. and Elmwood Ave.	93	587	5.2
Beaver St. and Cowperthwait St.	95	600	5.3
Mt. Auburn St. and Aberdeen Ave.	97	613	5.4
Broadway and Ellsworth Ave.	98	619	5.5
Cambridge St. and Quincy St.	99	626	5.6
Mass. Ave. and Martin St..	141	892	7.9
Regent St. near R. R......	186	1175	10.5
Western Ave. and Hews St..	196	1238	11.0
Hampshire St. and Elm St..	220	1390	12.4
Kendall Square	332	2098	18.7
Mass. Ave. North of M. I. T. Bldgs.	380	2400	21.4
Mechanics Square	414	2618	23.2
Mean	149	939	8.3
Median	97	613	5.4

The extremes in each series were widely separated in quantity. In Series I the maximum amount of solids collected was about five times that of the minimum amount, in Series II and III it is about nine times. An attempt was made to have the sampling stations scattered in all classes of districts throughout the city from the residential to the manufacturing sections. Series I had no samples in purely industrial districts. It represented residence and business districts, and included local ways and main thoroughfares. A more general representation was included in Series II and III. The locations at which the smallest amount of solids was collected were in the residence districts in each set of experiments, while the largest amounts were collected near the industrial centers or in portions of the city where conditions favored dust formation. The effect of an industrial center with large factories and poor streets upon the atmosphere of the surrounding district is shown in Series II and III. The highest figures for total solids were obtained at Mechanics Square. This is the center of a very poor district of the city in which there are numerous factories and plants, and streets in poor condition. The exceptionally high figure in the second series might easily have been due to a cleansing of the air from small particles of dust and soot during the rainfall of that period. There were two or three hard showers.

USE OF SPOT MAP TO SHOW DISTRIBUTION OF DUST.

Of interest in connection with the distribution of dust over the city was a spot map prepared from the results of these experiments. A median figure was taken for each set of experiments. Upon a large map of the city pins were placed at the location of each station, the pin being green if the amount of dust collected at that station was less than the median figure, and red if it was more than the median. A survey of all the streets in the city had been made during

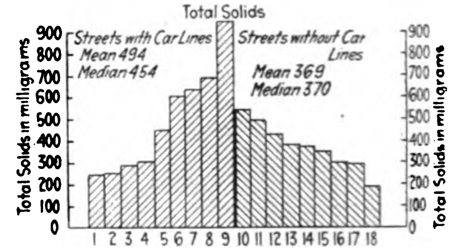
the period of dust collection and a rating of good, fair, bad and indifferent given to them in accordance with their state of repair and cleanliness. Upon the map the rating was indicated by coloring the street, or portion of it blue, green, red or yellow respectively to conform with the rating given. After all the pins had been placed it was observed that practically all the green pins were in the blue or green street areas, and the red pins in the red of yellow areas. In other words, the low dust figures were obtained on streets where the roadway was in good condition, well oiled, or clean, and the high dust figures on streets that were rated as in poor condition or dirty.

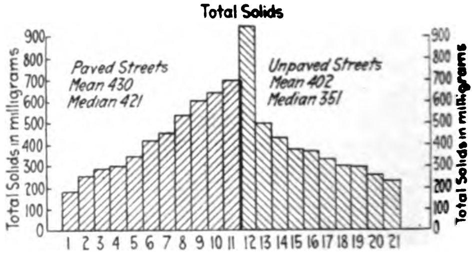
HIGH DUST DISTRIBUTION ON STREETS HAVING STREET CAR LINES.

The exception to this distribution was in the case of the main thoroughfares that were rated in good condition and that had street care lines upon them. Red pins, representing high figures for dust were found upon several of these. Massachusetts Avenue, the main artery of the city, had figures above the median throughout its length as did Cambridge Street. Mt. Auburn Street, another through street with a car line and good pavement had low figures for dust. This was explained by the fact that Mt. Auburn Street borders a parkway along the Charles River, and has very few buildings on that side of the street and almost no cross traffic along the portion of it where sampling stations were located.

Comparison of the results obtained in each of the three series of experiments shows that considerably more dust was collected for the period between April 2 and 14 than for the other two. The mean of all the results for this period showed that solids were collected at the rate of 2,409 milligrams per square meter per day; for the period between June 24 and July 13 the amount was 1,110 milligrams; and between July 31 and August 14, 939 milligrams. The differences are consistent with the conditions prevailing during each series. In the first a large proportion of the winter's accumulation of dirt laid on the streets or was in process of removal. The total wind movement on each of three days was in excess of 300 miles and on April 12 reached a velocity of 47 miles per hour. None of the streets had been oiled at this time, a factor which no doubt exerted considerable influence as there is a very large mileage of streets in Cambridge that have dirt or macadam surfaces.

The wind movement during the second and third series was about the same for each, but on three days of the second series there was rainfall in excess of 0.6 in. These showers were five days apart with very little precipitation on the days between them. Inasmuch as heavy rains have a cleansing effect on the air it is probable that considerable amounts of fine particles were precipitated by these showers.





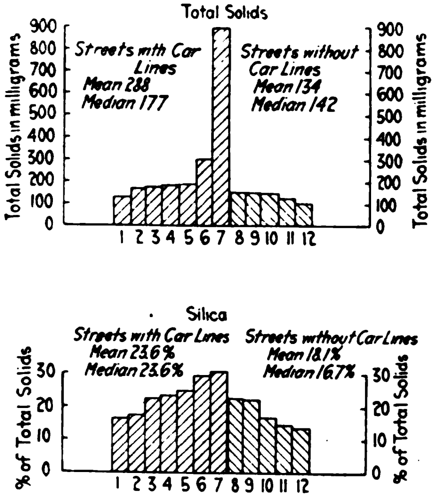
QUANTITIES OF DUST COLLECTED 20 FT. ABOVE VARIOUS STREETS, APRIL 2-14, 1914.

DESCRIPTION OF DIAGRAMS.

In Diagrams 1, 2 and 3 the determinations of each series have been arranged in order of magnitude and divided into two groups, according to whether the sample was taken on a street with a car line or without. In Diagram I a division is also made on the basis of paved and unpaved streets. The heavy center line at the intersection of the cross-hatching divides the two groups in each case. On account of the undue weight given to certain extreme results in computing the mean or average results the median fig-

ure as well as the mean has been indicated on the diagrams.

It will be noticed that in each diagram under the head of total solids both the mean and median figures are higher for those samples collected on streets with car lines than for those collected on

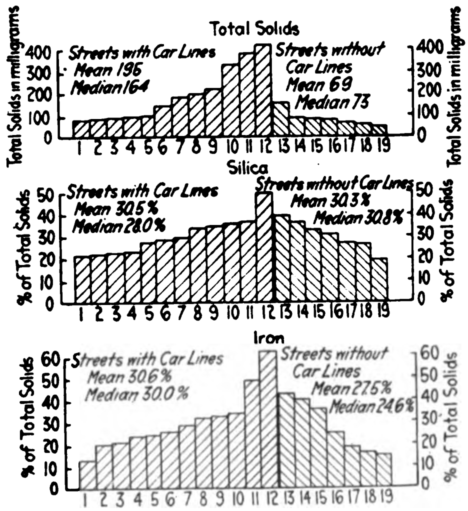


TOTAL SOLIDS AND PERCENTAGES OF SILICA IN SAMPLES OF DUST COLLECTED 20 FT. ABOVE VARIOUS STREETS, JUNE 29 TO JULY 13, 1914.

streets with no car lines. This is not on account of the poor condition of the pavements on car line streets, for with only one exception the survey showed the surface of such streets to be in a good state of repair and throughout the greater part of their length these streets were covered with a smooth surfaced material, such as asphalt, bitulithic or wood block pavement. The controlling factor in such cases is the rapid motion of car traffic over the streets. Unless the pavement between and close to the rails is kept clean a cloud of dust is raised with the passage of each car. The height and extent to which this cloud is scattered can be seen very well at night near street lights where a dark ground illumination occurs. The material scattered about consists of organic debris, gritty siliceous material and metallic dust from rails, wheels and brake shoes. All streets over which surface cars are operated should receive special attention from the street cleaning department.

Diagram I. also shows the relative amounts of dust deposited over paved and unpaved streets. At the period when the samples were taken the unpaved streets were in their worst condition, as they had not yet been oiled. Inasmuch as the paved streets showed larger amounts of dust than the unpaved it is assumed that the effect of car traffic is reflected again in this diagram. Nearly all the paved streets had car lines running over them.

Full knowledge of the significance of dust in the atmosphere and its effects upon the health of the individual is not possessed by scientists at the present time. So far as these things have been studied, principally in connection with dusty trades, the opinion has been formed that the most dangerous dust particles are those of a gritty, rough na-



TOTAL SOLIDS AND PERCENTAGES OF SILICA AND IRON IN SAMPLES OF DUST COLLECTED 20 FT. ABOVE VARIOUS STREETS FROM JULY 31 TO AUGUST 14, 1914.

ture. There is a large amount of such material in street dust.

As the studies outlined in this paper progressed the idea was suggested that a determination of the siliceous material and iron in the solids collected might be of interest. Accordingly, analyses of silica and iron were made on some of the samples. The results are presented graphically in Diagrams 2 and 3 where the amounts of these substances are shown in percentages of the total solids collected.

The percentage differences are not great, but in each case the average results are somewhat higher for paved streets. The figures do not necessarily imply that the same percentages of silica and iron existed in the street dust as in the dust of the air. It was undoubtedly higher in the former, for silica and iron have a higher specific gravity than organic matter and would tend to settle out of the air more quickly than the latter. As already stated the samples were collected 20 ft. above the street.

The survey of atmospheric conditions in cities is a field of investigation that is rather new to sanitary science, but one that will be thought of seriously as our interest in such matters is quickened by an increasing knowledge of subjects that relate to the air we breathe. It is the opinion of the authors that the studies in Cambridge, as outlined in this paper, suggest a method of undertaking such surveys, which with refinements and adjustment to particular conditions will prove valuable in the information it furnishes. By its use an idea may be gained of the total amount and character of the solids precipitated from the air in a given period of days, the distribution of these suspended impurities geographically, and the extent to which their quantity is affected by varying weather conditions. Interpretation of the results, in connection with a thorough knowledge of the streets, life and industries in the districts investigated, will generally suggest specific remedies for the improvement of these districts.

The above investigation was made in the Laboratory of Sanitary Engineering of Harvard University and was made possible by funds kindly furnished by Ernest C. Dane of Brookline.

Heating Data for Varying Conditions

Heating data for other than the usual conditions form an important part of the report submitted by the Education Comittee at the recent meeting of the National District Heating Association. This portion of the report was contributed by James A Donnelly, of New York.

TRANSMISSION FROM RADIATING SURFACES.

Under "Transmission from Radiating Surfaces," the following table is presented showing the relative surface in pipe coils and wall radiators:

Mr. Donnelly then refers to the lower

RELATIVE SURFACE IN PIPE COILS AND WALL RADIATORS.

COILS TEN FEET LONG								WALL RADIATORS			
1 in, Pipe		1¼ in. Pipe		1½ in. Pipe		2 in Pipe					
No. of Pipes	Square Feet	No. of Pipes	Square Feet	No. of Pipes	Square Feet	No. of Pipes	Square Feet	No. of Sec's	Sq. Feet Surface each sec.		Total Surface Sq. Ft.
3	10	—	—	2	10	—	—	2	5		10
4	13⅓	3	13	—	—	2	12½	2	6		12
5	16⅔	—	—	3	15	—	—	3	5		15
—	—	4	17⅓	—	—	3	19	3	6		18
6	20	5	21⅔	4	20	—	—	3	7		21
7	23⅓	—	—	5	25	4	25	4	6		24
8	26⅔	6	26	—	—	—	—	3	9		27
9	30	7	30⅓	6	30	5	31	5	6	on end	30
10	33⅓	8	34⅔	7	35	—	—	5	7	on end	35
11	36⅔	9	39	—	—	6	37½	4	9	on end	36
12	40	10	43	8	40	—	—	6	7	on end	42
14	46⅔	—	—	9	45	7	44	5	9	on end	45
15	50	11	47⅔	10	50	8	50	7	7	on end	49
16	53⅓	12	52	11	55	9	56	6	9	on end	54
18	60	14	60⅔	12	60	10	62½	7	9	on end	63
22	73⅓	17	74	14	70	12	75	8	9	on end	72

pressures now carried on steam heating plants through the introduction of vacuum return line and vapor systems and figures that the radiators are often operated at a temperature of not over 210° F. This temperature of the steam is, therefore, taken as a standard condition and is used in compiling the following table of the transmission of heat in B.T.U. per square foot per hour, under the standard conditions of 70° room temperature:

TRANSMISSION OF HEAT IN B.T.U. PER SQUARE FOOT PER HOUR FOR 70° F. ROOM TEMPERATURE.

Cast iron direct radiators.

	45 in.	38 in.	32 in.	26 in.	22 in.
1 column...	262	270	275	279	285
2 column...	241	250	257	263	270
3 column...	222	231	240	248	255
4 column...	210	218	225	233	240

Wrought pipe coils 1 in. to 2 in. dia..	300
Cast iron wall radiators, on side...	290
Cast iron wall radiators, on end....	280

COMPARATIVE RADIATOR TRANSMISSION AT VARIOUS TEMPERATURES.

Mr. Donnelly then quotes the point as brought by C. A. Fuller in THE HEATING AND VENTILATING MAGAZINE for March, 1915, that the rate of heat transmission from a direct radiator does not vary directly as the difference in temperature between the radiator and the room. The coefficient per degree difference is found to vary approximately 2% for each 10 degrees variation from standard conditions. Based on this variation, the following table is included in the report, showing the comparative transmission at different temperatures:

In order to find the temperature of a radiator for any desired transmission, the above process may be reversed by the application of the following formula:

Temperature of radiator $= \sqrt{280T + 32{,}400} - 110$. In which T equals transmission in B. T. U. per square foot per hour.

Example: If the tranmission of a radiator is 250 B. T. U. under standard conditions of room 70°, radiator 210°, what will be the temperature of the radiator for a transmission of 125 B. T. U. per square foot per hour?

Solution: 280 x 125 equals 35,000 which added to 32,400 equals 67,400. Extracting the square root gives 259.6. Subtracting 110 leaves 149.6, which is the required temperature of the radiator.

The following table gives the proportionate heat losses from buildings, with varying outside minimum temperatures, and with a room temperature of 70°. Also the proportionate amount of radiation to heat the room to 70° with steam at the ratdiator at 210°.

PROPORTIONATE HEAT LOSSES WITH VARYING OUTSIDE MINIMUM TEMPERATURES.

Outside min. tem. Deg. F	Inside or room tem. Deg. F	Proportionate heat loss	Proportionate radiation required
35	70	0.50	0.50
30	70	0.57	0.57
25	70	0.64	0.64
20	70	0.71	0.71
15	70	0.79	0.79
10	70	0.86	0.86
5	70	0.93	0.93

COMPARATIVE RADIATOR TRANSMISSION AT DIFFERENT TEMPERATURES.

Steam temp. Deg. F.	Room temp. Deg. F.	Diff. temp. Deg. F.		Stand. co-eff.			B. T. U. per sq.ft. per hr.	Propor. trans. co-eff.
260	70	190	x	1.785	plus	10%	373	1.49
250	70	180	x	1.785	plus	8%	347	1.39
240	70	170	x	1.785	plus	6%	322	1.29
230	70	160	x	1.785	plus	4%	297	1.19
220	70	150	x	1.785	plus	2%	273	1.09
210	70	140	x	1.785	Standard		250	Condition. 1.00
200	70	130	x	1.785	minus	2%	227	0.91
190	70	120	x	1.785	minus	4%	206	0.82
180	70	110	x	1.785	minus	6%	185	0.74
170	70	100	x	1.785	minus	8%	164	0.66
160	70	90	x	1.785	minus	10%	145	0.58

Zero	Standard	70	1.00	Conditions	1.00
— 5		70	1.07		1.07
—10		70	1.14		1.14
—15		70	1.21		1.21
—20		70	1.29		1.29

The proportionate surface required to heat a room to 70° under the above standard conditions for the radiator is the same as the proportionate heat loss for any outside minimum temperature.

The following tables gives the proportionate heat losses from buildings, the proportionate transmission from direct radiators, and the proportionate radiation required (*with steam at* 210°) for various room temperatures, when *the outside temperature is zero.*

PROPORTIONATE HEAT LOSSES FROM BUILDINGS		PROPORTIONATE TRANSMISSION OF DIRECT RADIATORS		PROPORTIONATE SURFACE REQUIRED FOR HEATING	
Room temp. Deg. F.	Proportionate loss in B. T. U.	Diff. in temp. Between rad. and room. Deg. F.	Proportionate transmission in B. T. U.	Room temp. Deg. F.	Proportionate surface req., sq. ft.
35	0.50	175	1.34	35	0.37
40	0.57	170	1.29	40	0.44
45	0.64	165	1.24	45	0.52
50	0.71	160	1.19	50	0.60
55	0.79	155	1.14	55	0.69
60	0.86	150	1.09	60	0.78
65	0.93	145	1.05	65	0.89
70	1.00 Standard	140	1.00 Conditions	70	1.00
75	1.07	135	0.95	75	1.12
80	1.14	130	0.91	80	1.26
85	1.21	125	0.87	85	1.40
90	1.29	120	0.82	90	1.56
95	1.36	115	0.78	95	1.74
100	1.43	110	0.74	100	1.93
105	1.50	105	0.70	105	2.15
110	1.57	100	0.66	110	2.39
115	1.64	95	0.62	115	2.66
120	1.71	90	0.58	120	2.95

Assuming that the rate of heat loss from a building varies directly with the difference between the outside temperature and the building temperature, and considering the heat loss for zero outside 70° inside as the standard, or 100 per cent.; the second column shows the proportional loss of heat from a building when the outside temperature is zero, and the inside temperature is as given in the first column.

Assuming that the rate of transmission from a direct radiator to the air of a building is in proportion to their difference in temperature, with a variation in the rate of transmission of 2 per cent., greater or less, for each 10° increase or decrease in their temperature difference, and considering 140° difference in temperature (steam 210° building 70°) as standard, or 100 per cent. transmission, the fourth column shows the proportionate transmission when the difference in temperature is as given in the third column.

Assuming that under standard conditions of outside temperature zero, building temperature 70°, and radiator temperature 210° (or 140° difference between the radiator and room) the amount of radiation necessary is 100 per cent., the proportionate amounts of radiation given in the sixth column are those necessary to heat a building to the temperatures given in the fifth column, when the outside temperature is zero.

NOTE. The amount of surface required for heating is always obtained by dividing the heat loss from the building by the amount of heat transmitted per square foot of radiation. Therefore, as may be seen from the above tables, the proportionate amount of surface required for heating is obtained by dividing the proportionate heat loss from the building by the proportionate transmission of the radiator, in each case.

The foregoing table may be used to find the proportionate amount of radiation necessary to heat a room to any desired inside temperature, other than 70° F.,

when the outside minimum temperature is other than zero. Find the difference between the ouside temperature and the room temperature in the first column; divide the proportionate heat loss opposite this amount, in the second column, by the proportionate transmission opposite the difference in temperature between the radiator and the room, as given in the fourth column, and the result will be the proportionate amount of radiation required.

EXAMPLE: What is the proportionate amount of radiation required to heat a room to 90° F., with a temperature of 20° F. below zero outside?

SOLUTION: The difference in temperature between 20° outside, and 90° F. inside, is 110°. Opposite 110 the protionate heat loss, or 1.57, is found in the second column. The difference in temperature between the radiator and the room (steam 210°, room 90°) is 120°. Opposite this the proportionate transmission, 0.82 is found in the fourth column. Divide 1.57 by 0.82 and the quotient, 1.91, is the proportionate amount of radiation required.

Comparison of Operating Conditions.

Gravity hot water systems using an open tank are usually figured for a maximum temperature of about 180° F. at the boiler, with a drop of 20° through the system, thus having 160° in the return at the boiler, or an average temperature at the radiators of 170°. Pressure water systems, using ordinary safety valves or mercury seals, as well as forced circulation systems (those using circulating pumps) are often figured as high as 220° to 230°, thus frequently maintaining an average for the radiators of 210° in zero weather.

Some attempts have been made to operate an entire heating plant under a steam pressure below that of the atmosphere in mild weather, varying the temperature of the radiator by the vacuum carried, in proper relation to the outside tempeature so that, with the entire radiator heated, its temperature would be at the proper point for maintaining the room temperature at 70°. In this case the various radiator temperatures would be the same as for a forced circulation hot water system, provided the radiator temperature for zero weather was the same (210°) for each system.

The following table gives the required temperature of the radiator for various outside temperatures for a forced water circulation or a vacuum steam system; the pressure of steam or the degree of vacuum which must be carried to maintain this temperature with the steam system and the B.T.U. transmission by a standard cast iron radiator under this temperature. Also the required temperature of the radiàtor and the transmission for a gravity circulation water system.

REQUIRED RADIATOR TEMPERATURE FOR VARIOUS OUTSIDE TEMPERATURES.

FORCED WATER OR VACUUM STEAM				GRAVITY WATER		
Outside temp. Deg. F.	Temp. of rad. Deg. F.	Pressure or vacuum of	B.T.U. per sq. ft.	Temp. of rad. Deg. F.	B.T.U. per sq. ft.	Perc't rad. fractional system.
—20	240	10.25 lbs.	322	192	211	1.29
—15	233	7.25 lbs.	304	187	199	1.21
—10	225	4.25 lbs.	286	181	187	1.14
— 5	218	2. lbs.	268	176	176	1.07
Zero	210	1. vac.	250	170	164	1.00
5	202	5.5 vac.	232	162	149	.93
10	194	9.0 vac.	214	157	138	.86
15	186	12.5 vac.	196	150	126	.79
20	177	15.5 vac.	179	144	115	.71
25	168	18.0 vac.	161	137	103	.64
30	159	20.5 vac.	143	131	92	.57
35	150	22.5 vac.	125	124	80	.50
40	140	24.0 vac.	107	118	69	.43
45	130	25.0 vac.	89	110	57	.36
50	119	26.5 vac.	71	103	46	.29
55	108	27.5 vac.	54	95	34	.21
60	96	28.3 vac.	36	87	23	.14
65	83	28.8 vac.	18	79	11	.07

In the last column the proportional amount of the radiator which is to be heated for various outside weather conditions is given for a fractional air-return vacuum or vapor system.

It will be noted that the degree of vacuum which it is necessary to carry in order to properly heat a building increases very rapidly for a comparatively slight rise in the outside temperature. This makes it practically impossible to carry a sufficiently low pressure and temperature to prevent overheating by this method alone. It is very difficult to maintain vacuums of even 15 to 20 in., and almost impossible to maintain one higher than this. It has, therefore, come to be considered much better practice to control the heating effect of a radiator by heating a portion of it by means of a fractional system, rather than attempt to heat all of the radiator, but to reduce its temperature in relation to the outside temperature by carrying a varying vacuum within it.

It will be seen from an examination of the column of radiator temperatures for a gravity water circulation, that where a system is designed for 170° water at the radiator in zero weather, if the heater is large enough to maintain the water at 192°, the radiation would then be sufficient to keep the building at 70° when the outside temperature was 20° below zero.

In the same way it may be noted that where a fractional vapor or vacuum system is designed for substantially atmospheric pressure in zero weather, if the boiler is large enough and the system is of such a type that it may be run at 10 lbs. steam pressure, the radiation being 29% below zero.

DATA FOR DESIGNING SYSTEM, BASED ON ORDINARY CONDITION.

In a moderate climate, where the temperature seldom drops below 10°, it is quite safe to design a steam system for atmospheric pressure at about 16° above zero outside temperature. This would make about 10 lbs. steam pressure necessary if the minimum of zero outside was ever reached. The standard hot water temperature may be shifted in the same manner. The result of these changes is shown at bottom of page.

The steam boiler or hot water heater should not, however, be reduced in size when the amount of radiation is reduced in this manner. The size of the boiler should be proportioned from the B.T.U. losses of the building from the minimum outside temperature to 70° inside.

The following table gives the proportionate radiation required to heat a building from zero outside to 70° inside, with varying maximum temperatures of the radiators. Also the proportionate size of the boiler or heater for the corresponding maximum temperatures of the radiators.

Temp. of radiator Deg. F.	Transmission B. T. U.	Pro. surface required sq. ft.	Pro. boiler load steam	Pro. load hot water
240	322	.78	1.29	—
230	297	.84	1.19	—
220	273	.92	1.09	—
210	250	1.00	1.00	1.52
200	227	1.10	—	1.38
190	206	1.21	—	1.26

FORCED WATER OR VACUUM STEAM				GRAVITY WATER	
Outside temp. Deg. F.	Temp. of rad. Deg. F.	Pressure or vacuum of	B. T. U. per sq. ft	Temp. of rad. Deg. F.	B. T. U. per sq. ft.
Zero	240	10.25 lbs.	322	192	211
5	231	6.5 lbs.	299	185	196
10	221	3.0 lbs.	276	178	181
15	211	1.0 vac.	253	171	166
20	201	5.5 vac.	230	163	151
25	191	10.0 vac.	207	155	136
30	180	14.0 vac.	185	147	121
35	168	18.0 vac.	161	139	105.5
40	156	21.0 vac.	138	130	90
45	144	23.0 vac.	115	121	75
50	131	24.5 vac.	92	112	60
55	117	26.0 vac.	69	102	45
60	103	28.0 vac.	46	92	30
65	87	28.5 vac.	23	81	15

180	185	1.35	—	1.13
170	164	1.52	—	1.00
160	145	1.72	—	.88
150	126	1.99	—	.77

Organization of Building Data League.

One of the most unique organizations of its kind is the recently-organized Building Data League, Inc., an outgrowth of the Architects' Bureau of Technical Service. Its membership is made up of consumers, organized to secure through co-operation exact and reliable information as to the quality and relative economic values of the vast number of materials and devices used in the construction and equipment of buildings. The league's purpose is to establish market standards in the building industry, so that the consumer may readily secure accurate information and a working knowledge of available materials, methods and devices. On the other hand, the league will direct the attention of the producer to the demands of the consuming class with a view of securing high standards and methods in the manufacturing and marketing of products. The league is a New York corporation, with headquarters at 105 West 40th Street, New York.

One of the important functions of the league is to conduct investigations and examinations, where necessary, of given products and to give them a market rating. As a rule, however, the league will accept such standards of quality as are established by recognized authorities.

The investigations mentioned and the establishment of standards will be in the hands of technical committees appointed by the league. In this connection the league will prepare for the use of its members standard specifications which will accurately define quality, making distinctions between the several established grades. The idea is to supplement the work being done by the United States Bureau of Standards, the American Society for Testing Materials and similar bodies.

The league's investigations will comprise the following important considerations from which ratings are to be determined:

1. Performance of the product under service test.
2. Production, including raw materials, shop practice, plant efficiency, capacity, organization and deliveries.
3. Market, including demand, adaptability, cost, difficulty incident to installation and service efficiency.
4. Sales, including character and reliability of advertising matter and claims, selling tactics, the producer's attitude toward the market, organization and financial responsibility.

The producer is expected to meet the expense of the investigation. The league also plans to publish a monthly bulletin and ultimately to establish technical libraries for the use of its members.

Among the technical committees for the first year are those on mechanical devices and equipment, sanitary equipment, insulation, building codes and structural methods. Upon the assumption that the members of the league will not be able or willing to devote the time and labor necessary for the conduct of adequate investigations and for the preparation of standard specifications and reports, an agreement is made with the Building Data Co., Inc., an organization formed especially for the purpose of rendering technical service to the league.

Membership in the Building Data League is open to any individual or any person as a representative of a firm, corporation, or association, which is a non-producer of materials, devices, methods or apparatus entering into the construction or equipment of buildings, or the improvement of real property. The dues are placed at $9.00 and the subscription to the league's bulletin at $1.00. There is no initiation fee.

In the present organization of the league the chairman is Lansing C. Holden, F. A. I. A.; first vice-chairman, Charles L. Borie, Jr., A. I. A.; second vice-chairman, James S. Macgregor; secretary, Sullivan W. Jones, A. I. A., and treasurer, Frank Sutton, M. Am. Soc. M.E.

The affairs of the league are managed by a board of twenty-five governors, made up of engineers and architects

International Engineering Congress.

A general programme has been published of the International Engineering Congress of 1915 and the Engineering Society conventions, which will be held at San Francisco, Cal., from September 16 to September 25. The programme covers in outline the conventions of the four national societies supporting the International Engineering Congress, the meetings of the congress, and the excursions which have been planned to various points of engineer interest. A map is included containing a key to the excursions.

William Gordon Corporation, of New York.

A new firm of heating engineers and contractors has recently been organized by William Gordon, formerly chief mechanical engineer for the Thompson-Starrett Co., New York. It is known as the William Gordon Corporation, with headquarters at 107-109 West 23rd Street, New York.

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THE WRITER of "Cows May Come and Cows May Go, But the Bull Goes on Forever" may not have been thinking of manufacturers' catalogues. But we suspect he had some of them in mind. The average manufacturer has never been distinguished for his modesty in his printed matter, although it is a noteworthy sign of the times to see a more careful regard for accurate statements in the more important engineering catalogues. One of the trials of the editor in describing new products very often is literally to tone down the claims made with the utmost confidence, but it may be, without a shred of engineering proof.

In the general merchandise field a movement has been successfully carried on through some of the magazines and newspapers to test the various articles offered to the public and to give in the printed advertisements some mark to indicate proved quality. Of course, such stamps of approval depend for their value upon the integrity of the examiners, but so far there has been every inducement to conduct the tests and report the results with absolute faithfulness.

There has now been inaugurated a movement upon somewhat similar lines in the building field. In this case, the investigations and tests are to be conducted under the supervision of a body of architects, chemists and engineers. It is proposed by this means to establish market standards in the building industry, so that the consumer may readily secure accurate information and a working knowledge of available materials, methods and devices. In other words, it is proposed to give various building materials and apparatus a market rating.

Such a service, if faithfully carried out, will no doubt be of great value to the man who writes the specifications and is really so important a movement as to raise honest doubts of its feasibility. We have in mind now the testing and rating of the more elaborate mechanical apparatus where the results may be affected to a degree through faulty technique. Here again not only is the element of integrity involved, but accuracy as well. However, it is possible to thoroughly and accurately test every appliance on the market and to make the results of such tests available to those interested. Such an achievement has long been dreamt of, and it must be admitted that the lines on which the idea is now being planned give considerable promise of success.

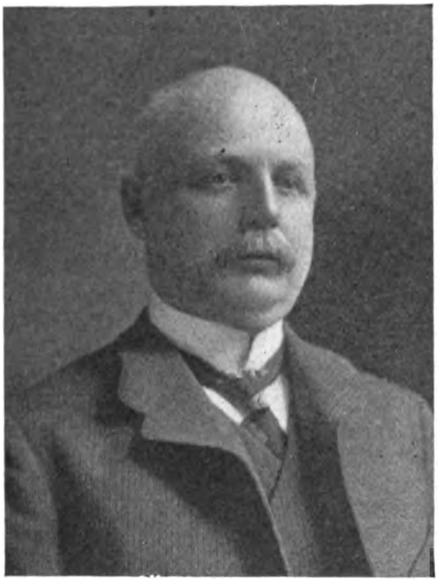
AS USUAL during the summer months, the weather charts for five representative American cities will be omitted. Their publication will be resumed in the Fall.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Twenty-Seventh Annual Convention, Milwaukee, Wis., June 21-24, 1915

A typical Western meeting, in which the representation was largely from the Middle West, was the way most of the delegates characterized the twenty-seventh annual convention of the National Association of Master Steam and Hot Water Fitters, held in Milwaukee, Wis., June 21-24, 1915.

While some important business was transacted, notably in connection with a change in the scope of the association's "Trade Resolutions," the most significant feature of the meeting was the lavish hospitality of members and friends of the association in Milwaukee, the convention city. The Milwaukee committee fairly outdid itself in connection with the entertainment programme and achieved a record that it will be difficult for future committees to equal. Moreover, the various details of the programme had been arranged with evident care and were carried out with scarcely a hitch, greatly adding to the pleasure of the occasion.



JOHN T. BRADLEY, ST. LOUIS.
Re-elected Prsident of the National Association of Master Steam and Hot Water Fitters.

At the opening session the convention was welcomed by Mayor G. A. Bading of Milwaukee. The mayor was followed by Judge John C. Karel of Milwaukee, whose eloquence was marked as he seconded the mayor's welcome. President John T. Bradley responded to the addresses of welcome and then presented his address.

PRESIDENT'S ADDRESS.

President Bradley, after expressing his pleasure in meeting again with his friends and fellow-workers in the craft, traced the development of the association and its accomplishments since its beginning in 1889.

He stated that the present enrollment is approximately 900.

"Evolution," he continued, "is going on in our affairs, as well as in the affairs of others. We are solidifying in our common interests. We are getting closer together every day. We are more closely united in the bonds of fellowship. We are dropping former suspicions and prejudices so that when we meet it is with the friendly greeting of confidence. We meet as men of honor and respect each other. We respect and obey the decisions of our officers; in them we have every confidence and to them we confide the care and management of our affairs for the year.

"Those who have been in touch with the work for so long a period appreciate fully the change that has taken place. At the time the founding of the national association was suggested, every master fitter was from a business standpoint the

enemy of every other master fitter, with the result that frequently the owner and architect took advantage of him. Many of the master fitters at that time had little business experience and in many cases comparatively little knowledge of the engineering side of their business. The result was that they entered into contracts containing guarantees that were impossible of fulfillment and the road was strewn with the wrecks of the concerns who attempted to do the impossible."

At another point in his address President Bradley said:

"The national association does not aim to formulate or enforce its suggestions by any mandatory process. It does not attempt to overturn, by radical measures, the customs of the steam-fitting business unless such customs are clearly wrong. Nor does it anticipate speedy reforms from its efforts because it does not attempt to dictate to or control the local and State associations which form part of it. It is, however, an organization for the purpose of acting unitedly on problems which are of common concern in the belief that in such united action lies the greatest safety. The national association has no other purpose or object than to act for the best interests of all."

In referring to the work of standardization done by the association, President Bradley said:

"A form of valuable work done by the national association is in line of standardization. Every master steam fitter who was in business twenty-five years ago knows, and probably experienced, the troubles incident to the various sizes, dimensions, weights, ratings, etc., adopted by different manufacturers (each according to his own notion) of articles entering into our work.

"In those days if you had to change an ordinary flange it required the most minute instructions in order to secure one that would replace the one removed. The national association took this matter up and, after much consideration, a 'Standard Schedule for Flanges' was adopted in 1894.

"Some manufacturers kicked vigorously, claiming it meant expense to them to alter patterns, etc. This was true, but, after all, who paid the bill? The object sought was accomplished by the master steam fitters specifying flanges in accord with the standard flange schedule, and finally all the manufacturers complied.

"It is safe to say that the value to the steam fitting trade of the fixing of that schedule has been greater than all the expense or cost of the association since its incorporation. It must be apparent that it would have been impossible to accomplish this by individual effort. Only a large organized body with great purchasing power was equal to the task.

"Another valuable piece of work done by the national association was that of bringing about the adoption of the '1915 U. S. Standard Schedule of Flanged Fittings and Flanges.'

"The annoyance and expense caused by the variations in different makes of standard and extra heavy flanged fittings became unbearable, and the matter was placed in the hands of our committee on standardization by a resolution adopted at the seventeenth annual convention, held at Atlantic City, N. J., in June, 1905.

"The subject was a very difficult one. The cost of the time spent on the problem by men whose time is very valuable would amount to many thousands of dollars if charged for at their regular prices.

"The work was carried on in the face of many obstacles, and at last, after many years, we now have a *standard* which provides that for which we persistently fought; to wit, the interchangeability of flanged fittings. Its benefits will be enjoyed by the whole fraternity and their clients, the consumers.

"Thus it can be seen that the national association, in connection with other engineering bodies, but on its own initiative standardized flanged fittings and flanges, and is still engaged in the work of standardizing boiler ratings; radiator valves, and other materials entering into the construction of steam and hot water heating systems, all of which the committee on standardization will make reference to in its report."

At the conclusion of the president's address, the following committee appointments were announced:

Credentials: Otto A. Wurm, Michigan; M. J. Callahan, New York; Frank

CONVENTION GROUP OF THE NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS, IN FRONT OF THE AUDITORIUM, MILWAUKEE, WIS.

Downey, Wisconsin; J. F. Garvey, Iowa, and C. F. Little, Ohio.

Nominating: A. E. Kenrick, Massachusetts; F. H. Meadows, Wisconsin; P. F. Maginn, Pennsylvania; John T. Sadler, New York, and E. B. Harris, Utah.

Constitution and Rules for Convention Procedure: N. L. Danforth, New York; G. F. Reeke, Wisconsin, and C. P. Tietze, Michigan.

Appeals and Grievances: F. G. Carthey, Utah; E. Tunstead, Minnesota, and William Hunter.

Association Improvement: E. T. Child, New York; Chris. Sodemann, Missouri; and E. H. Sonneman, Wisconsin.

Auditing: Charles Geoghegan, New York; Stewart A. Jellett, Pennsylvania, and William H. Curtin, New York.

Distribution of Reports: E. D. Smith, New York; Albert Luebke, Wisconsin, and D. F. Edwards, Missouri.

Resolutions: William H. Curtin, New York; Walter A. Lawson, New Jersey, and Fred Kaufman, Wisconsin.

At the afternoon session, on Tuesday, June 22, a lecture was delivered by William Mather Lewis, field secretary of the Navy League, on "Peace Insurance," in which the speaker made a plea for a more adequate system of naval defense.

This address was followed by the report of the Committee on Standardization. After referring to the work in connection with the establishment of the "1915 United States Standard Schedule of Flanged Fittings and Flanges," and the publication of the schedule in chart form by the association, the committee reported progress in the standardization of radiator valves and in standard specifications for cast iron heating boilers.

Secretary Henry B. Gombers presented his report at this meeting and this was followed by the report of the treasurer, Juan A. Almirall. The convention then went into executive session.

A short open session was held Wednesday morning, June 23, when the convention was addressed by Charles K. Foster, vice-president of the American Radiator Co., speaking as a representative of the National Boiler & Radiator Manufacturers' Asociation. The installation of officers was made at the Thursday morning sesion, all of the officers being re-elected, with the exception of Otto A. Wurm, of Milwaukee, a member of the board of directors, who was succeeded by Julius A. Ziesse, of Grand Rapids, Mich. The officers as elected are:

President, John T. Bradley, St. Louis; first vice-president, Juan A. Almirall, New York; second vice-president, Frank G. Carthey, Salt Lake City; third vice-president, Edmund Grassler, Milwaukee; treasurer, J. E. Rutzler, New York; sergeant-at-arms, John C. F. Trachsel, Philadelphia.

Board of directors: William H. Oakes, Boston, chairman; Noble P. Bishop, New Haven; John T. Bradley, St. Louis; Frank G. Carthey, Salt Lake City; N. Loring Danforth, Buffalo; Edmund Grassler, Milwaukee; Juan A. Almirall, New York; J. E. Rutzler, New York; and Julius A. Ziesse, Grand Rapids.

CHANGE IN TRADE RESOLUTIONS.

The important change referred to in connection with the association's "Trade Resolutions" consisted in the omission of the following from the former resolutions:

"Those manufacturers and wholesale dealers who are in accord with us in this belief we look upon as our friends; our interests are mutual, and we shall use our best efforts to advance such mutual interests.

"For the information of the craft and the benefit of our friends we may, upon satisfactory evidence of the facts, print their name in our Official Bulletin, under the heading of 'List in Accord.'"

The full "Trade Resolutions" as adopted at the Milwaukee convention are as follows:

"The members of this association believe in trade protection. By trade protection we mean that manufacturers of, and wholesale dealers in, materials which enter into the construction of heating and ventilating systems, steam power plants and other pipe work done by those engaged in this craft, shall sell such materials for use in such work to those only who are regularly established in our line of business, and shall leave the preparation of plans and specifications to the heating contractor, the architect and the engineer. We shall endeavor by every

legal and legitimate means to further trade protection."

The Entertainment.

In addition to the regular entertainment programme a number of private dinner parties served to fill every spare moment during the convention. The following are the more formal entertainment features.

Tuesday at noon the ladies to the number of one hundred were luncheon guests of the Milwaukee Association in the Colonial Room of the Hotel Wisconsin. The souvenirs consisted of boxes of bon-bons, silver spoons and post card sets. The luncheon committee was ably assisted by Arthur Ritter and H. G. Issertell, of New York, in carrying out the arrangements. At the conclusion of the luncheon Mrs. Halsey expressed the thanks of the Western ladies and Mrs. Henry B. Gomers spoke for the Eastern ladies present. On motion of Mrs. A. F. Sheahan, a toast was then drunk to the health of the Milwaukee committee.

In the afternoon the ladies were taken in a body to the "movies."

The "big night" of the convention was the same evening and took the form of a carnival cabaret, the host being the American Radiator Co. The diners donned carnival paper caps of all conceivable patterns and proceeded to make merry with music and dancing to add to the festivity. Advantage was taken of the occasion to present Charles K. Foster, general manager of sales of the American Radiator Company, with a silver-plated miniature automobile in appreciation of his faithfulness as a convention goer. It was pointed out that Mr. Foster has attended 26 out of the 28 conventions held by the master fitters.

President H. W. Ellis of the Johnson Service Co., of Milwaukee, was the recipient of a jardiniere and 7 ft. palm, presented to him by the Milwaukee Association in recognition of his interest and assistance in carrying out the entertainment programme.

Another recipient of convention honors was William G. LeCompte, of Jenkins Bros., New York, "perennial chairman of the entertainment committee," who was presented with a set of cuff buttons by "twelve brother Elks." This presentation was made by Judge John C. Karel, of Milwaukee, and his reference to an imaginary part played by Mr. LeCompte as a dummy in connection with a story he told, was responsible for a characteristic response by Mr. LeCompte, who acknowledged his thanks in a manner befitting a dummy, his speech being entirely in pantomime. Needless to say, it brought down the house.

On Wednesday afternoon, the entire convention party was taken in some 70 automobiles for a pleasure trip about the city. Banners were attached to each automobile bearing the title of the association, and the cavalcade made an impressive showing as it swung through the streets. A stop was made at the Elks Club, where a light luncheon was served.

In the evening the annual bowling matches were held at Kurtz's Bowling Academy. The master fitters' team, consisting of Messrs. Stohr, Pellinick, Downey, Mueller and Dusold, won from the supply men with a margin of 101 pins. The supply men's team was composed of Messrs. Somers, Ritter and Witt. The winners in the ladies' bowling match were Mrs. Wenzel, first prize; Mrs. John T. Bradley, second prize; Mrs. Christie, third prize; Mrs. Noerenburg, fourth prize; Mrs. Osborne, fifth; Mrs. Zuelke, sixth; Mrs. Freeman, seventh; Mrs. Shaw, eighth; Mrs. Sonnerman, ninth; Mrs. Wagner, tenth; Mrs. Yunghaus, eleventh, and Mrs. Callahan.

Following the final adjournment of the convention Thursday morning, the members and guests in the afternoon were taken on a boat ride on Lake Michigan as the guests of the Johnson Service Company. A special boat was chartered for the occasion and the party numbered over 200. During the trip the winners of the bowling matches were presented with their prizes. A band was on board and soon the upper deck was cleared for dancing, which was generally participated in. A light luncheon was also served during the ride.

The Milwaukee committee, which did so much to make the convention a success, was easily distinguished by the uniform dress of its members. The full committee comprised the following: H. Dearsley, H. Franke, S. Thompson, W. E. V. Shaw, F. Downey, M. Mueller, W. A. Bowers, H. Sohns, F. Mueller, R. Zuelke, R. G. Wenzel, J. Christie, A. F. Bowers, B. Freeman, J. Volk, R. Kelleman, O. Juttner, R. Lade, C. J. Fox, J. Saxer, H. S. Bowers, W. Noerenberg, I. Harriman, E. A. Netz, S. May, F. H. Meadows, E. Grassler, A. Luebke, F. Kaufman, E. Henoch and A. J. Striebel.

The Exhibitors.

C. A. Dunham Co., Marshalltown, Ia., had a room reserved in which the Dunham steam traps and other devices used in this system of heating were on exhibition. The representatives of the company were George W. Best, manager, and C. L. Chase.

Consolidated Engineering Co., Chicago, Ill., had a duplicate of its display at the recent

convention of the National District Heating Association. Those on hand in the interest of the company were B. E. Van Auken, president; John F. Hale, vice president; Roy Van Auken, C. E. Greenfield and A. H. Probst.

H. W. Johns-Manville Co., New York, showed its line of pipe coverings and boiler insulation. The company was represented by C. A. Holmes, Otto Gahns, A. L. Klug, H. P. Meyer, E. J. Holzhausen and A. H. Pierick.

Boylston Steam Specialty Co., Chicago, Ill., exhibited full sized models of its vacuum pump governors, pressure regulators and steam traps. John Boylston had charge of the company's exhibit.

Dolve Valve Co., Chicago, had samples of the Dole packless radiator valves on exhibition. The exhibit was in charge of T. H. Tweed.

Johnson Service Co., Milwaukee, Wis., passed around attractive note books, bound in red leather. On the boat trip on Thursday, the company presented souvenir thermometers to the ladies on board, while the men were given attractive paper weights.

Convention Notes.

One of the interesting informal gatherings of the convention was the reunion of the "old guard," in the rooms of William G. LeCompte, of the entertainment committee, on Monday evening. Later in the evening the "old guard" and a number of others were the guests of the Consolidated Engineering Company at a cabaret and midnight dance in the grill room of the Charlotte Hotel.

One of the events of the boat trip on Thursday was the presentation of a silver loving cup to Edmund Grassler, and a silver cigarette case to A. H. Meadows, both of the Milwaukee entertainment committee, in appreciation of their efforts toward the success of the convention. The presentation was made by E. L. Downey, on behalf of the Milwaukee committee.

A trip to the Pabst breweries for the ladies was an event not on the regular programme but one which proved decidedly interesting. J. Barton Garfield, of the entertainment committee, accompanied the party. The entire process of the manufacture of beer was shown and explained by the Pabst company's guides.

Before the convention disbanded William G. LeCompte was re-elected chairman of the manufacturers' entertainment committee, and J. Barton Garfield was re-elected secretary and treasurer.

The record of the convention would not be complete without a note of the fact that Alfred E. Kenrick, who never misses a convention, was in his accustomed place. Past President E. D. Smith, of New York, was also present and officiated at the installation of the officers.

Prize for Best Essay on Sanitary Arrangements on Board Ship.

Announcement is made that the Royal Sanitary Institute, of London, this year will offer the Henry Saxon Snell prize, consisting of $255.00, and the silver medal of the institute, for the best essay on "Suggestions for Improvements in the Sanitary Arrangements and Appliances Suitable on Board Ship for Passengers and Crew and for Cattle and other Live Stock." Special consideration will be given to suggestions for ventilation, heating and cooling, sanitary conveniences, water supply, sleeping quarters and store and feed rooms. Essays must be delivered on or before November 1, 1915. Details may be obtained by addressing E. White Wallis, secretary of the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S. W., England.

To Market American Products in Belgium.

Announcement is made of an organization of Belgian business men in England to introduce in Belgium, as oson as the European war is over, American products and manufactures and, also, to employ as agents, representatives, etc., a large number of Belgian manufacturers and business men who have been partly ruined but who still possess enough capital and can give the necessary guarantees as agents, dealers, etc. The organization is being developed by Willy Lamont, of Antwerp, Belgium, whose temporary addres is Shardhighs, Halstead (Essex), England.

"Home Electrical" at the Panama-Pacific International Exposition.

A novel exhibit at the Panama-Pacific International Exposition is the "Home Electrical" in the Palace of Manufacturers. This is a full-sized model home in which electricity is made to perform the domestic tasks and labors. Electricity cooks, washes, launders, sweeps, dusts and fulfills countless other household duties, and it also heats, lights and cools the house.

This is one of the exhibits of the General Electric Company. The home is in no sense an exhibition to demonstrate the radical things that may be done with electricity in a house, all of the electrical devices shown being suitable for the average family.

Honeywell Heating Specialty Co., Wabash, Ind., in accordance with a recent announcement, will hereafter use brazed or welded expansion tanks in connection with its tank-in-basement method of hot water heating.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

47—Air Cooling With Water.

QUESTION: How much water at an initial temperature of 70° F. will it require to cool 200,000 cu. ft. of air and steam at 300° F. to 100° F., if the weight of the vapor is 0.00898 lbs. per cubic foot, and the time interval one minute?

ANSWER: The barometer is 29.88 in. mercury or 14.67 lbs. pressure. The weight of vapor is 200,000 cu. ft. x 0.00898 = 1796 lbs. The weight of dry aid will be the total, less the 1796 lbs. of vapor at the volume of the pressure and temperature given, multiplied by the weight per cubic foot at that pressure and temperature.

The condition, volume per pound, and total heat of the vapor, from a steam table, is as follows:

Volume per pound, 30.57 cu. ft. Total heat above 32° at 100° F., 1103.6°. Latent heat of evaporation, 1035.6 B. T. U. per pound.

The volume of the vapor is 1796 lbs. x 30.57 cu. ft. = 54,903.7 cu. ft. 200,000 cu. ft. — 54.903.7 = 145,096.3 cu. ft. dry air at 300° F. The weight of dry air at 14.7 lbs. pressure and 300° F. is as follows per cubic foot: The weight of dry air at 0° is 0.086354 lbs. per cubic foot at 14.6963 lbs. 14.67 ÷ 14.6963 = 0.9982 of the volume. The volume due to change in temperature, is, at 300°, 460 ÷ 760 = 0.6053.

The weight of dry air at 300° F. is 0.86354 x 0.6053 x 0.9982 = 0.05217 lbs. per cubic foot. 145,096.3 x 0.05217 = 7569.7 lbs. dry air. The heat required for the dry air will be 7569.7 (air) x 200 x 0.2375 = 359,560.75 B. T. U. 1796 (vapor) x 88 B. T. U. per pound = 158,048 B. T. U.

At 100° F. the water vapor per pound of air is, at saturation or dew point, 0.04304 lbs. per pound. 7569.7 x 0.04303 = 325.8 lbs. The vapor condensed at 100° saturation will require 1796 — 325.8 = 1470.2 lbs. 1470.2 x 1035.6 B. T. U. = 1,522,539.12 B. T. U.

The total B. T. U. per minute will be:

Air	359,560.75
Vapor	158,048
Vapor condensed........	1,522,539.12
Total	2,040,147.87

If the water is heated from 70° to 100° F. the pounds of water required will be, per minute: 680,049 ÷ 8 1/3 gal. = 8200 gal. per minute. 10% to 20% should be added to this on account of the efficiency of the spraying apparatus. If the water is thoroughly atomized, the less water will be required up to the theoretical amount.

If the apparatus is arranged on the counter current principle, ringing the coldest water in connection with the cooler gases, the water may be heated from 70° to 200° F. or through 130°. There will then be required 30 ÷ 130 = 23%, or 1886 gal. per minute, instead of 8200 gal.

Heating surface may be provided for water and gas or the water may be pumped through twice. Still another method would be to raise the temperature in two stages.

Current Heating and Ventilating Literature.

DUST REMOVAL—

The Removal of Dust from Machines. F. R. Parsons. Design and installation of dust-removal plants. Ills. 1500 w. Prac Engr—March 25, 1915. 40c.

FACTORIES—

Heating and Ventilating System of American Cigar Co.'s Plant. W. L. Durand. Example of modern tendencies. Ills. 1200 w. Power—April 6, 1915. 20c.

FANS—

The testing of Ventilating Fans. Thomas Bryson. With special reference to the measurement of pressure. 2000 w. Col Engr—April, 1915. 40c.

STEAM PIPES—

Piping and Supports in Municipal Plant. A. D. Williams. Unusual features. Ills. 900 w. Power—April 6, 1915. 20c.

Stresses in Steam Pipes. S. U. Tuspin. Forces set up by expansion and necessity of providing for them. 1000 w. Elec Wld—April 10, 1915. 20c.

Supporting Steampipe Lines. F. R. Parsons. Suggestions for avoiding leakage troubles. Ills. 1000 w. Mech Wld—April 9, 1915. 40c.

LEGAL DECISIONS

Modification of Contract By Correspondence and Payment.

A building contractor contracted with a subcontractor to install a heating plant for which the latter was to receive $2,075, of which $1,000 was to be paid upon the completion of the work, and the balance on the 15th of December, 1910, the work to be finished on the 15th of October, 1910. On the 5th of October, 1910, the heating plant had been completed with the exception of putting in a certain boiler which the contract called for, the shipment of which had been delayed by the manufacturers thereof from whom the subcontractor had ordered it. On that day the subcontractor wrote the contractor requesting payment of $1,000 on the job, but recognizing that under the terms of the written contract no payment was due until the work was completed, and reciting the fact that it was all completed except furnishing and setting the boiler which had been delayed by the boiler manufacturers, who had promised to ship it that week, and that it would be installed within a few days after its arrival. On the 10th of October the contractor paid the subcontractor the $1,000 requested. On the 21st of October, before the boiler had arrived, the building was destroyed by fire. The contractor subsequently sued to recover the $1,000 paid. It was held that the correspondence and payment modified the contract, so that the payment must be given the same effect as if it had been provided for in the original contract, and there was no implied promise on the part of the subcontractor to repay the money because of the destruction of the building.—Peck-Hammond & Co. vs. Miller, Kentucky Court of Appeals, 175 S. W. 347.

Covenant to Heat Premises—Slight Breach—Notice to Landlord.

In an action for rent due on a written lease of an office building, from which the lessee had moved out before the termination of the lease, the jury returned a general verdict for the defendant on the theory that he had a right to vacate the premises because of the failure of the plaintiff to heat the leased rooms according to the provisions of the lease. On appeal, the court said that, while the numerous cases dealing with covenants to heat leased premises are not all in harmony, the following propositions are supported by reason and authority:

1. A mere slight temporary inconvenience to the tenant does not justify him in throwing up his lease. A trivial breach is not sufficient, but the breach must be substantial and of such duration that it can be said that the tenant has been deprived of the full use and enjoyment of the leased premises for a material period of time.

2. The landlord is entitled to notice to the effect that the heat contracted for is not being furnished, and has a reasonable time after notice is given to remedy the defect complained of, and until such time has elapsed the tenant has no right to quit the premises because of the alleged breach.

It is not easy to avoid some fluctuations in heat in a climate like that of Wisconsin. The facts were peculiarly within the knowledge of the tenant. If he was being deprived of the full beneficial use of the space he had leased, it was his busines to say so, and it was the busines of the landlord to remove the cause of complaint. But until a complaint was lodged, and the lessor failed within a reasonable time to remedy the trouble complained of, the tenant was not at liberty to treat the lease as terminated. The defendant testified that at times he complained to the janitor of lack of heat. This was natural enough if more heat was desired when the complaint was made. The building was not leased from the janitor, however, and there was nothing to show that he was an agent of the owner for the purpose of receiving notice that the terms of a lease were being violated, any more than he was for the purpose of receiving rent. The agents in charge of the building were well known to the defendant, and occupied the office directly under the one used by the defendant. Rent was paid monthly to these agents for more than two years, and the court thought that an important notice of the kind here involved should have been served on them, rather than on the janitor. But if the agents were chargeable with knowledge of what had been communicated to the janitor, the defendant had not shown any sufficient reason or justification for vacating the premises. Judgment for the defendant was reversed and ordered to be rendered for the plaintiff.—Northwestern Realty Co. vs. Hardy, Wisconsin Supreme Court, 151 N. W. 791.

No Liability for Negligence of Independent Contractor.

A radiator company employed a transfer company to make deliveries for it. The transfer company exercised an independent calling, routed the deliveries, took other deliveries with those of the defendant, received an agreed compensation per hundred

weight, and the defendant exercised no control over it. A driver, in making a delivery, negligently left some radiators on the sidewalk space and a pedestrian fell over them and was injured. In an action in which the case as to the radiator company was dismissed, it was held that the transfer company was an independent contractor and the radiator company was not liable for the doctrine of respondent superior.—Winters vs. American Radiator Co., Minnesota Supreme Court, 151 N. W. 277.

Features of Nineteen Typical Heating Franchises.

In the report of the station record committee, at the recent convention of the National District Heating Asociation, interesting features were tabulated of nineteen typical heating franchises for central station heating plants. Following are some of the more important facts brought out:

In all of the cities authority was granted to occupy the streets. The terms of the franchises varied from 20 to 50 years, 25 years being the usual term. In a few cities authority was granted to connect to the public sewers. In four cases the authority granted was for a restricted territory only.

Regarding conditions and restrictions, the grant is often subject to the city laws and the city generally approves the location of mains. In one case the city reserved location for the company for six months. The city generally approves construction in the streets. In six cases permits for construction had to be obtained.

In regard to proving and sealing all meters at desire, and to test meter on consumer's request, only one franchise had this provision. The fee for such test was $1.00 and the allowable variation in accuracy 2%.

It is usually specified that the companies are not to interfere with present pipes in streets, that they are not to unnecessarily impede streets and drains, that they are to use precautions to avoid accidents, to put up barriers and lights, not to do permanent injury to streets or trees, and to restore streets to their original state of usefulness.

The requirements regarding the opening of trenches at one time vary from "not more than necessary" to "500 ft." "one week" and "15 rods." In two of the franchises it was specified that the company was not to stop traffic in the street more than six days and ten days, respectively. Three franchises called on the company to refill trenches in the manner specified.

Regarding the maintenance of repaving, this was mentioned in but two franchises. In one case the time specified was one year and in the other no time was specified. Some of the companies agreed to pay for the city repaving where the city so desired.

Seven companies agreed to file maps of their underground work with the city, one franchise reading "annually." Six companies agreed to remove or change construction at the city's order. The time limit for beginning construction ranged from two months to one year, the company in the latter case agreeing to spend $100,000 on mains within that time. The time limit for beginning heating service varied in an interesting manner, as follows:

One year, 2,000 ft.; one year; one year, 1½ miles; eleven months; eighteen months; 21 months, ¾ mile; sixteen months, 50 buildings; 18 months; 10 months; six months, 1 mile; 14 months; 18 months, ¼ mile; and 12 months.

In two instances the franchises had clauses that the company was not entitled to damage from work done by the city. One franchise specified that the company was to use modern and effective appliances, while another contained clauses that it was to use standard improvements on mains and that it was to employ only union men when available.

Four of the franchises required bonds or deposits against failure to begin construction within the time limit. These were fixed at $10,000, although in one case $500 was the amount mentioned. Bonds against all damages to the city from company operation were required in nearly all cases, the amounts ranging from $1,000 to $25,000. Four companies were required to give a continuing guarantee on paving repair, amounting in one case to $500, and, in the other three cases, to $1,000.

A curious requirement in one franchise was that the company should pay a city sinking fund tax of 3 cents per foot of main, the total of such payments not to exceed $100,000. In several cases the special taxes were arranged on a percentage of the gross receipts, amounting to from 2% to 5%.

One company secured a clause providing for a penalty for injury to the company's equipment or operation. Another franchise had a penalty clause where steam fitters did not get the company's permit for changes.

In only one case was it provided that the company was to establish rules for the customer's equipment and to fix the amount of the radiation. In only one case, also, was a cooling coil required.

The heating season, according to three franchises, was from September 15 to May 15; from October 1 to June 1; and from September 20 to May 20. Two franchises

Exhibit of the Consolidated Engineering Company, of Chicago, Ill.

Exhibit of American District Steam Company, of North Tonawanda, N. Y.

VIEWS IN THE EXHIBIT HALL AT THE RECENT CONVENTION OF THE NATIONAL DISTRICT HEATING ASSOCIATION.

had provisions for reductions of charges for insufficient heat.

As far as rates are concerned, there is a clause in one franchise that the rate was to be the same per square foot to all consumers. In another it was specified that there should be a maximum rate per square foot. Such maximum rates were given in five of the franchises as follows:

Thirty-five cents for steam and 20 cents for hot water; 20 cents; 17 cents; 30 cents for steam and 20 cents for hot water; and 6 cents per month. In two cases the maximum rates were given per 1,000 cu. ft. of space, the figures being $4.00 and $6.00, respectively.

The maximum rate per 1,000 lbs. of steam was mentioned in three franchises as follows: 75 cents, etc., to 45 cents; 50 cents; 65 cents. The rate to the city for municipal buildings was mentioned in five franchises, ranging from "free heat" to "city hall free," "minimum price," "city hall one-half average" and "20% less."

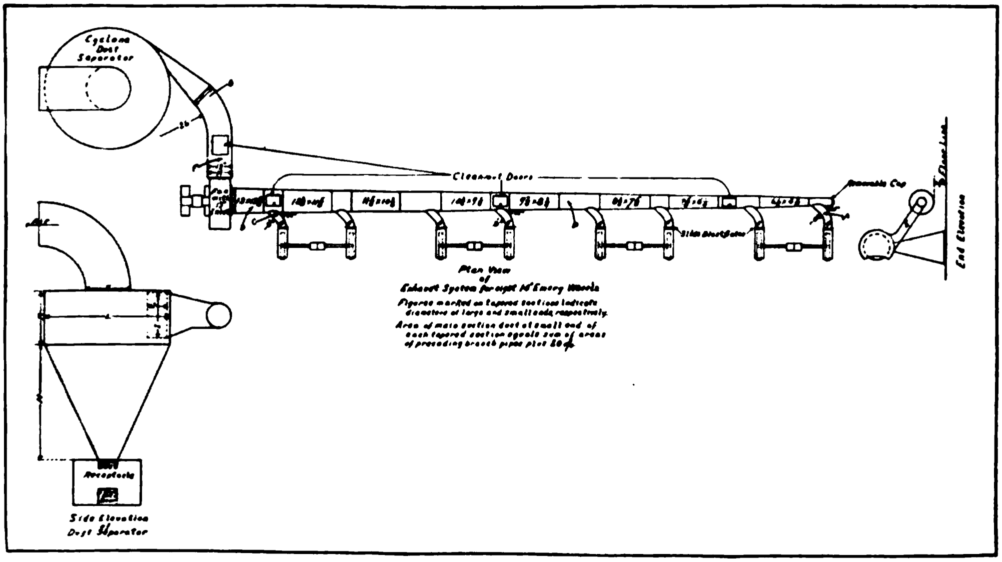
In three cases it was agreed that rates may be fixed by the city, one franchise adding the clause "at five year periods." One of these franchises had the further provision that 20% of the users must sign such a petition and that a net profit of 10% must be allowed in fixing the rates. One franchise only provided for arbitration in settling rates.

In four cases the service company was to furnish all near mains. Regarding extensions, one franchise had a clause that the mains must have sufficient capacity. Four franchises had clauses regarding the business per foot of main before extending. These ranged from "user each 75 ft.," "700 cu. ft.," "agree with city" and "reasonable." Regarding free extensions to curb and lot lines, two franchises specified "curb" and one, "lot." One franchise stated that the company must extend all services to curb line on order.

On the subject of exclusive franchises, this was mentioned in four cases and prohibited in each case. In three cases, there was mention of purchase by the city and the method was specified. The franchises averaged from 250 to 3,200 words in length.

New Rules Promulgated by the New York State Industrial Commission.

Four bulletins recently issued by the Industrial Commission of New York State have recently been published. They contain new rules relating to the sanitation of factories and mercantile establishments; to the equipment, maintenance and sanitation of foundries; to the milling industry and malt-house elevators; and to the removal of dust, gases and fumes. The latter is the most recent of the rules, having become effective May 15, 1915. This bulletin goes into the matters of hoods, size of branch pipes, size of main pipes and fan inlets and outlets, suction, arrangement and construction of pipes, clean-out doors, dampers and fire doors, ventilation, belts, and plans. The



TYPICAL PLAN, ENDORSED BY NEW YORK STATE INDUSTRIAL COMMISSION, OF EXHAUST SYSTEM FOR EIGHT 14-IN. EMERY WHEELS.

foregoing apply to grinding, polishing and buffing wheels.

Additional rules are given for machines creating dust or fumes; fumes, vapors or gases; lead dusts and fumes.

Under recommendations for the size of the cyclone separator or dust collector, a table is reproduced giving dimensions of separators stated to be suitable for metallic dusts and wood shavings. It is stated that the separator should be selected the area of whose inlet is at least as large as the area of the discharge pipe from the fan. For light buffing dusts, lint, etc., the air outlet from the top of the separator should be so large that the velocity of discharge will not exceed 300 to 480 ft. per minute; a separator should be selected of which the other dimensions are proportionate. The air outlet should be provided with a canopy or elbow to exclude the weather, but should be otherwise unobstructed. There should be ample clearance under the separator for the accumulation or storage of the dust, which should never be allowed to pile up as high as the botom of the separator.

The bulletin contains a drawing, which is here reproduced, showing an exhaust system laid out in conformity with these specifications for eight 14-in. emery wheels. The branch pipes would have to be not less than 4½ in. in diameter. It is pointed out that the installation for buffing wheels would have to be considerably larger in many respects. The bulletins are published from the headquarters of the Industrial Board, at 381 Fourth Avenue, New York.

National Warm Air Heating and Ventilating Association.

Fifty members of the National Warm Air Heating and Ventilating Association attended the organization's annual meeting in Detroit, Mich., June 9. In opening the meeting President John D. Green presented an earnest plea for greater publicity of warm air furnace heating through an organized publicity campaign. The balance in the treasury as reported by Treasurer W. G. Wise, was $1,267. Secretary Allen W. Williams stated that one of the most important accomplishments of the past year had been the compilation of a mailing list of dealers. About 20,000 names were sent in, containing some duplicates. The names have all been sorted alphabetically by States and cities and all duplications eliminated. It is the intention of the association to furnish copies of this list to its members.

One of the interesting papers read at the meeting was that presented by Professor Arthur C. Willard of the University of Illinois, on "Testing Warm Air Furnaces for Efficiency and Commercial Ratings."

All of the officers were re-elected as follows: President, John D. Green, Detroit, Mich.; vice-president, F. T. Giblin, Utica, N. Y.; treasurer, W. G. Wise, Akron, O.; secretary, Allen W. Williams, Columbus, O.; executive committee: John A. Howard, Dowagiac, Mich.; E. P. Miller, Marshalltown, Ia., and Charles Seelbach, Cleveland, Ohio.

Other papers read at the meeting were: "Bearing of Codes on Warm Air Heating," by Frank K. Chew, and "Combustion in Heating Apparatus," by R. A. Davenport. The report of the committee on legislation and building code was allowed to go over. The proposed code provided, among other things, for official inspection and probable inspection fees and it was thought the association should proceed carefully in this matter.

NEW DEVICES

A New Magazine Feed Boiler.

An important addition to the line of magazine feed boilers is announced by the Newport Boiler Co., 6312 Wentworth Avenue, Chicago, Ill. It is known as the Newport adjustable magazine feed boiler, being designed especially for homes and apartment buildings where maximum heating results must be obtained with a minimum of attention and expense. The inventor is Charles F. Newport, for many years manager of the Ideal Heating Co., of Chicago. Several installations have already been made in Chicago and vicinity and the company is issuing an impressive list of testimonials regarding its economical features and ease of operation.

One of the most noteworthy features of this boiler is the low height of its water line, which is 40½ in. in steam boilers as large as 2,100 sq. ft. capacity. This is a point that is of special advantage where the basements are low, or when using vapor systems, indirect radiators, etc. Its coal magazine is stated to be larger than that of any boiler of the same type. In this connection, the coal doors are comparatively low, which contributes to the ease of firing.

The manufacturers call special attention to the adjustable water cooled magazine throat, which permits the burning of large sizes of coal and coke, as well as the smaller and cheaper sizes of hard coal and coke.

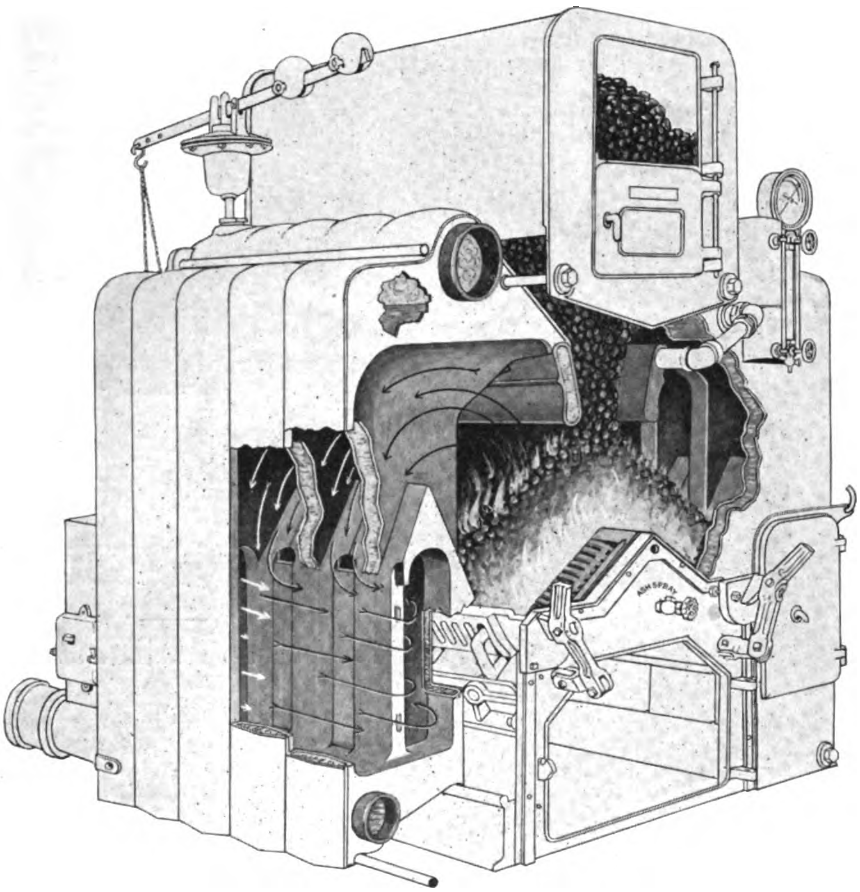
In other words, the size of the throat may be adjusted according to the size and kind of fuel being burned. It is also possible to use one side of the grate in mild weather. In addition, the flue travel on the Newport boiler is adjustable. This is accomplished by removing the flue plates located in the flues, short-circuiting the gases into the smoke outlet, thereby raising the temperature of the flue and increasing the draft. In this way the boiler may be made to work fully up to the capacity of the flue to which it is attached.

The sloping grate of the Newport boiler is self-cleaning, so that the sifting of ashes is unnecesary. The greatest accumulation of ash in a boiler of this type is at the lower end of the grate. In this boiler the connecting bar is placed above the grate. This bar has openings for the admission of air, the same as the grate, while on the inside are located ribs for the purpose of agitating the fire more violently in this corner when the grate is gently shaken, thereby evenly cleaning the grate.

Still another feature emphasized by the manufacturers is the ash pit spray. A water spray, by a turn of a valve, sprinkles the ashes so that their removal is not accompanied by the usual clouds of dust.

The Newport boiler is equipped with an exclusive patented combined check and draft, balanced by the adjustment of the regulator weight. The hottest gases first come in contact with the crown sheet and overhanging fire surfaces. They then follow downward between the sections into the outside flue, then forward into the inside flue from which they pass rearward to the smoke box, thus leaving the boiler at the coolest part. The flues are located below the fire in the coolest part of the boiler in order to absorb more heat from the gases.

Rapid water circulation in the boiler is secured by means of the vertical unob-



CONSTRUCTION OF NEWPORT ADJUSTABLE MAGAZINE FEED BOILER.

structed thin waterways located above the fire and in the flues.

New High Pressure Pyrometer Instruments.

A new line of high pressure resistance thermo-electric pyrometers for temperatures up to 3000° F. is being placed on the market by the Bristol Co., Waterbury, Conn. The millivoltmeter movements of these new instruments are all of the pivot jewel bearing dead beat type and are made by the Weston Electrical Instrument Company especially for use with thermo couples. These instruments may be used with Bristol patented base metal couples for measuring temperatures up to 2000° F., and with standard platinum rhodium couples or the Bristol patent compound couples with platinum rhodium tips for measuring temperatures up to 3000° F.

Fig. 1 is an illustration of the switchboard, or wall type, high resistance model 319, and Fig. 2 shows the portable high resistance model 322. The instruments are provided with zero adjusting devices which afford a simple and quick way of adjust-

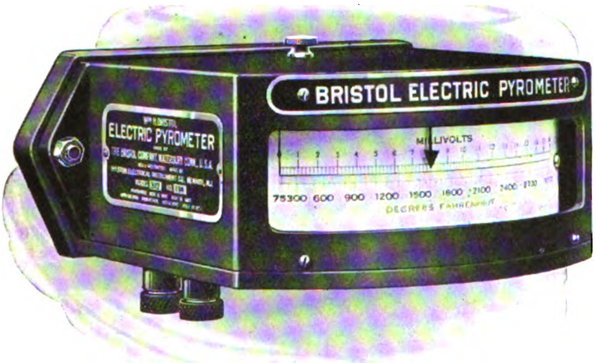


FIG. 1. SWITCHBOARD OR WALL TYPE OF PYROMETER.

ment for different "cold end temperatures" and as the movements are of the pivot jewel-bearing type, they are not affected by ordinary vibrations in shops. Switchboard model 319 is provided with a normal index which can be set at any desired point on the scale. Portable model 322 weighs about 6 lbs. and 6 oz. It is stated that when the instruments are calibrated for a scale range of 2000° F. for use with base metal couple or for a range of approximately 65 M. V., the resistance would be upward of 350 ohms and the temperature error would consequently be less than 1 per cent. for a

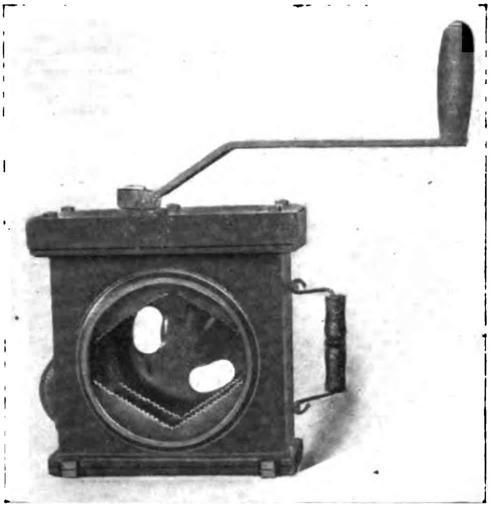
FIG. 2. PORTABLE HIGH RESISTANCE MODEL.

change of 75° F. This extremely high resistance also makes these instruments practically independent of length of leads and lengths of couples. The high sensibility also makes them available for low ranges of temperature where an open scale is required.

The Hillegass Portable Hand Pipe Reaming Machine.

The machine, shown in the accompanying illustrations, is a new and original device, being the first portable hand reamer put on the market for pipes larger than 1 in. in diameter. Mr. Hillegass, the inventor, during his forty years of experience in the pipe fitting trade, has long felt the necessity for a practical portable pipe reaming device. This machine is equally adaptable for use in piping for water, steam, gas or vacuum, and the inventor particularly recommends its use in iron conduit work for concealed electric wiring.

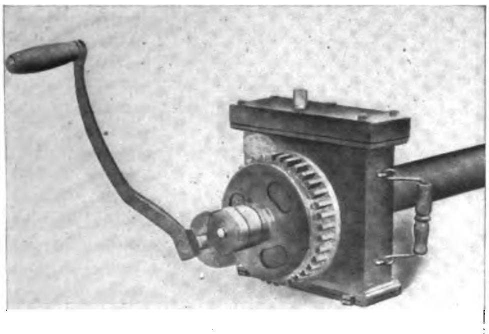
The Hillegass portable hand pipe reaming machine weighs 25 lbs. and reams nine sizes of pipe—¾-in. to 4-in., inclusive. It is constructed of maleable iron and steel castings. The cutting reamers are of high carbon steel. The jaws will take in a 4-in. coupling, making it possible, by using the coupling as a nipple holder, to ream a 4-in. nipple.



PORTABLE HAND PIPE REAMING MACHINE.

The machine is attached to a pipe in a manner similar to any hand threading machine, by means of self-centering chuck jaws. These jaws are so designed as to have the necessary advantages of an expensive universal chuck, and yet the construction is sufficiently simple so that it is inexpensive to build and to keep in repair. The cutting reamer has a shaft which slides on two keys, or feathers, through the hub of the main gear and is carried forward into the pipe by means of a hand feed nut similar to that on a drill-ratchet. Thus the cutting reamer, in operation, has both a rotating and longitudinal motion. The main gear is actuated by a drive pinion, which is turned by a hand crank. Three revolutions of the hand crank make one revolution of the main gear.

Since the machine was first developed, it has been given a severe service test of over a year, under practical conditions, to determine weaknesses and possibilities for improvement. So far it has done effective and rapid work at all times, showing no necessity for change in design. Machines will be put on the market about July, 1915, by the inventor and manufacturer, Henry Hillegass, Houghton, Mich.



PORTABLE PIPE REAMER ATTACHED TO PIPE.

A New Radiator Valve.

Two types of packless radiator valves for one-pipe gravity of vacuum heating systems, have recently been designed by E. H. Murphy, 1016 Marquette Building, Chicago, Ill., and are shown in the accompanying illustrations. The valve shown in Fig. 1 is adapted for use on hot water radiator and wall coils, and has been especially designed with a supply connection and control means at the top so that a person does not have to stoop to open and close the valve. The return connection is at the bottom of the radiator coil so that the water of condensation will drain from the radiator into the supply pipe through the water seal made intregral.

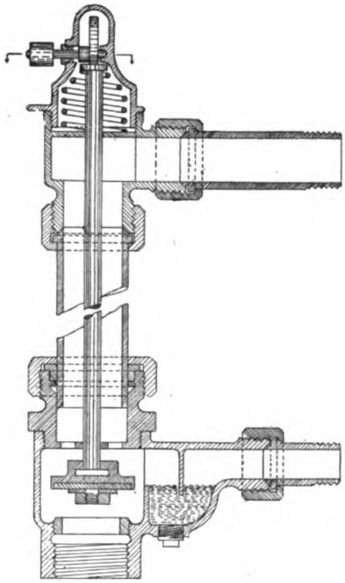


FIG. 1. NEW TYPE OF PACKLESS VALVE FOR HOT WATER RADIATORS AND WALL COILS.

The type of valve shown in Fig. 2 has the return and control at the bottom and can readily be adapted to supply the radiator either at the top or bottom.

These are positively opened or closed valves and cannot be stopped at any immediate point. It is possible with this valve to use radiators or coils of any length or size to guarantee a perfect circulation or a noiseless operation in both gravity and vacuum air line

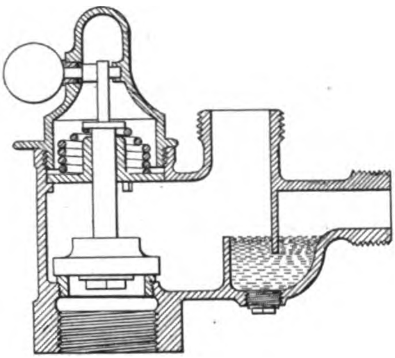
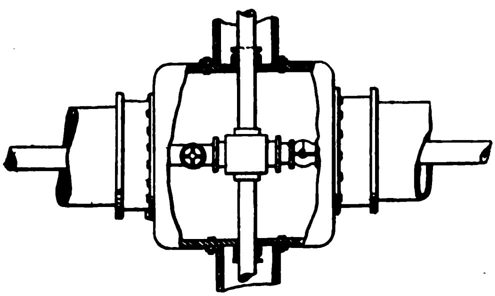


FIG. 2. NEW VALVE WITH CONTROL AND RETURN AT BOTTOM, ADAPTED TO SUPPLY AT EITHER TOP OR BOTTOM OF RADIATOR OR COIL.

systems. The return or condensation is carried to a constantly balanced liquid seal located within the valve body or casing and from which condensation overflows into the supply pipe. One of the features of these valves is the prevention of noise and water hammer.

Heat Distributing Device for Central Heating Systems.

A heat distributing device, for use on central heating lines, which is designed to distribute and equalize evenly along the line any amount of steam that may be required, has lately been patented by Samuel R. White, Bloomington, Ill., and is illustrated herewith. The device consists of a high pressure pipe installed inside of the low pressure pipe, with automatic reducing valves placed on the high pressure pipe. This enables a high pressure to be carried a long distance and reduction made to the pressure desired at any point needed. In an installation of this system at the plant of the Utility Heating Co., in Bloomington, Ill., last winter, the inventor states that they saved the expense of enlarging 1,000 ft. of line that was overloaded and also reduced the pressure at the plant nearly one-half.



STEAM DISTRIBUTING DEVICE FOR USE ON CENTRAL HEATING SYSTEMS.

One of the advantages mentioned in connection with the use of this device is that it superheats the steam in the low pressure line. The system, it is stated, can be installed in any plant at a small expense, while new plants can be installed at considerably less expense. In addition, live steam for cooking or any purpose that requires a high pressure of steam, can be taken off at any point along the line.

The inventor is now negotiating to place the device on the market.

Car Ventilator with a Water Chamber.

A window ventilator for sleeping cars, in which use is made of a water chamber to cleanse the air of dust and soot, has been invented by a Pullman car porter, W. E. McMullin, and has been tried out for the past three months on the trains running between Minneapolis and Aberdeen. It has lately been installed on the Pioneer Limited, one of the crack trains of the Chicago, Milwaukee & St. Paul Railway.

The device consists of a ventilator which is placed under the sash. At the front end is an opening, 5 x 8 in., which admits the air from the outside. The air is then forced, by a series of three wheels, through a body of water, so placed in the ventilator that it cannot be spilled either into the car or outside. By the movement of the train the air is whipped through a constant spray of water and is thus washed and cooled before passing into the berth. A catch basin apartment in the ventilator receives all the dirt and other debris.

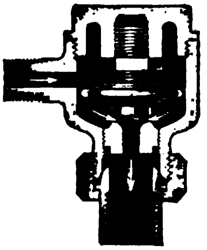
In addition to the installations mentioned, further tests are being made on the device by Mr. McMullin, L. J. Bussell and H. E. Bussell, on various sleeping car lines.

Novel Type of Air Line Valve.

Some unique features are embodied in the Marsh Thermodisk Paul air line valve, shown in the accompanying illustration. This valve is constructed entirely of metal. This includes the thermostatic diaphragm which is made of phosphor bronze, spun directly on the post at the top and the valve at the bottom, making a tight container for the volatile fluids and a sensitive diaphragm. The diaphragm is constructed to eliminate any possibility of rupture from alternate expansion and contraction, the

expansion being provided for in the corrugations. The edges consequently are free from excessive stress at all times. In this way the valve has but one movable part, opening and closing by means of the expansion and contraction of the diaphragm produced by the vaporization and condensation of volatile fluids which it contains. As will be seen from the construction of the valve, the air, on account of the large port, is eliminated freely. The port, however, is made so that it closes tightly on the arrival of steam.

The Thermodisk valve differs from the



MARSH THERMO-DISK PAUL VALVE.

Marsh original Paul air line valve, which, it is stated, was the original valve devised for the Paul system in that it has a metal diaphragm, while the old Marsh valve was made with a rubber composition expanding member. The manufacturers state that while the original Paul valve is still in extensive use, the new style of valve has been brought out to meet the popular demand, especially for certain installations. An important detail to which attention is called is that the Thermodisk valve in centers is interchangeable with the original Marsh air valve. In this way the valve may be applied promptly and without loss of time and cost of extra piping to the older installations as made with the Marsh original Paul valve. The manufacturers are Jas P. Marsh & Co., Chicago, Ill.

New Publications.

A STUDY OF BOILER LOSSES, by A. P. Kratz, has been issued as Bulletin No. 78 of the Engineering Experiment Station of the University of Illinois. This bulletin presents a critical analysis of the data taken from a series of twenty-five trials made on a 500 horsepower Babcock and Wilcox boiler in the University heating plant. The heat balance has been subdivided so as to isolate and determine the amounts of the several losses chargeable to the boiler, furnace and setting. Complete forms for calculating a series of boiler trials are also given. Tests were made also upon some samples of weathered coal. No difficulty was experienced in burning this coal, but it was found that it had deteriorated during the weathering until it was about the same composition and grade as fresh Vermilion County screenings. Copies of Bulletin No. 78 may be obtained gratis upon application to C. R. Richards, acting director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

CORRESPONDENCE

Figuring Size of Cooling Coils.

EDITOR HEATING AND VENTILATING MAGAZINE:

I note in your May issue, in "The Consulting Engineer" Department, an answer to Question 44, which refers to the size of cooling coils. I think that "Consulting Engineer" must have made a mistake in his figuring, and he has carried the mistake all the way through to the end of the example. His mistake is so large that it cannot be a mistake in the printing. I fail to understand where he gets his factor of 3 lbs. of water per square foot of radiation, for all engineers have agreed that 0.3 lbs. per square foot of radiation in still air is ample, with the surrounding air at or about 70° F., and a great many tests have shown that 0.25 was about all that 1 sq. ft. of radiation would deliver under the above-named conditions. However, it may be that the question referred to a fan blast coil, although it does not say so. If this is the case, then I can readily see that he might get 3 lbs. per square foot of radiation.

I would figure that this 5,000 sq. ft. of direct radiation would furnish 0.3 x 5,000 = 1,500 lbs. of water per hour and this, multiplied by 40 = 60,000 B. T. U. This, divided by 252 = 238.1 sq. ft. of cooling coil.

The writer, however, would use 500 sq. ft. on this job, if it was put up to him, as this has been his practice in the past and it usually has been sufficient to cool the condensate to the required temperature before delivering to the sewer. This is 10% of the amount of radiation in the building, while "The Consulting Engineer" says that it ought to be 48%; that is, if his figures are correct and he has not been misquoted. But his final result shows that he has been quoted correctly.

I call attention to this error, or what appears to me to be an error, so that it may be corrected in order that any reader not familiar with this work will not be led to make a mistake in figuring that might lose him a contract.

A. J. PURCELL.

Little Rock, Ark.

ANSWER BY "CONSULTING ENGINEER."

Regarding the size of cooling coils, the 3 lbs. per square foot was arbitrarily assumed to illustrate the method of determining the result. The correspondent's method of figuring and assumption are entirely correct.

The correspondent brings up a point which has caused considerable trouble. It is bad policy to base condensation on the pounds per square foot condensed unless the amount has been previously determined for that particular case. It is also dangerous to take a percentage of the radiation for the cooling coil. Sometime ago we had a question regarding the estimation of boiler power for a steam and for a hot water heating system to do the same work. The boiler power required in the two cases was widely different. This was caused by basing the power on the square feet of radiation.

In estimating boiler power the writer always bases the estimate on the B. T. U. loss from the building and not on the radiation, as radiation is frequently added or omitted for various reasons and the resulting boiler power will be correspondingly off.

In the same manner, when estimating the heat requirements for indirect heating, the writer always uses the heat required to raise the desired quantity of air through the desired temperature range, rather than to base the boiler power on the amount of indirect surface.

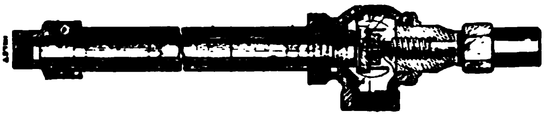
In the last part of the answer, it was intended to convey the idea that the cooling coils were seldom figured and generally old radiators that happened to be handy, were used.

Trade Literature.

POWELL ACCESSORIES, including Powell expansion joints for working pressures up to 125 lbs., Powell angle swivel coupling with expansion sleeve, Powell Swing joint, as well as the company's line of Union composite disc valves, and the new Powell "Irenew" valve for working pressures up to 150 lbs., are the subject of a booklet recently issued by the Wm. Powell Co., Cincinnati, O., manufacturers of these accessories, as well as of the well-known White Star valves. A copy of the booklet may be had for the asking.

THERMOGRADE SYSTEM OF STEAM HEATING in operation is illustrated in a clever card being sent out by the Consolidated Engineering Co., Chicago, Ill. By bending the edge of the card to and fro the pointer on the valve dial is moved from one position to another and at the same time the effect on the radiator is shown by varying degrees of shading, indicating a hot, half-hot and cold radiator. The card calls attention to the discovery of the basic principles for modulating the steam of a radiator made by Frederic Tudor in 1882. These are the principles incorporated in the Thermograde modulating valve. Reference is also made to the tests conducted by Prof. H. W. Spangles, formerly head of the engineering department of the University of Pennsylvania on a Thermograde modulation system of heating. Among other things a 34% fuel saving was shown. It is stated that all buildings at the university have since been Thermograde heated, and on April 22, 1915, the company received a contract for equipping three additional buildings. The company also markets the Kinealy air conditioning apparatus.

AND THEN CAME THE BARTON EXPANSION AUTOMATIC STEAM TRAP is the title of a Catalogue devoted to one of the latest types of steam trap, made by the Automatic Steam Trap & Specialty Co., Detroit, Mich. In addition to a full description of the device and its different applications, the catalogue is notable for the number of testimonial letters expressing the satisfaction of users. The Bar-



BARTON EXPANSION AUTOMATIC STEAM TRAP.

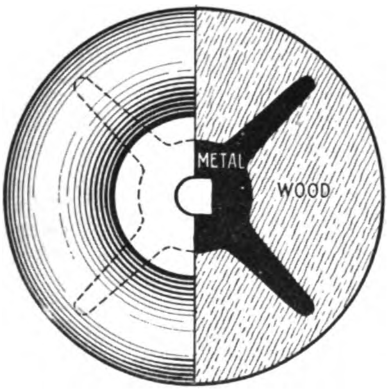
ton trap acts on the principle of the condensed water causing a lowered temperature which contracts the inner sleeve and automatically opens the trap for the water to escape. When the temperature is again raised by the incoming steam it closes the valve by expanding the sleeve. Another feature emphasized is that the trap provides a continuous flow that can be correctly metered to determine the exact amount of steam used in any plant. It is stated to be the only trap that will operate with both vacuum and gravity systems at all pressures. Size 3½x6 in. (standard). Pp. 16.

TYLER UNDERGROUND HEATING SYSTEMS, Pittsburgh, Pa., has published a new architects' and engineers' data sheet, which contains some sixty-one charts and tables relating to heating, as well as illustrations of the devices and construction features of the Tyler underground heating systems for central station heating work. The data sheet measures 30½ in. by 20 in.

J. C. HORNUNG, engineer, 111 West Monroe St., Chicago, Ill., has issued new bulletins (Bulletins 8, 9, 10 and 11) devoted, respectively, to the Hornung automatic pressure and temperature control valve, the Hornung automatic differential and temperature control valve, the Hornung central station special ex-

pansion joint and the Hornung B. C. condensation trap. The circulars are of uniform size, 6 x 9 in. standard, and in each case the data are concise and to the point. A table typical of those often found in the Hornung bulletins is reproduced herewith. It shows the amount of steam (vapor) required per square foot of radiation per season to main 70° F. inside at various annual outside temperatures.

"KANTSPLIT" VALVE WHEELS are featured in circular matter sent out by the Holton-Abbott Mfg. Co., West Somerville, Mass. This valve wheel is described as a strong metal wheel embedded in a wooden one. the spokes



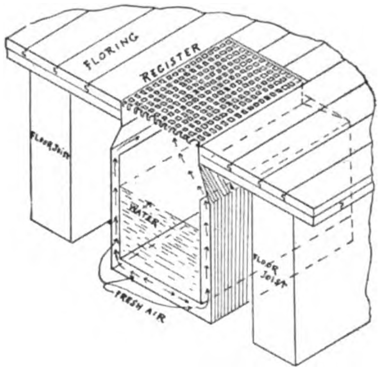
THE KANTSPLIT VALVE HANDLE.

of the former binding the fibers of the wood together, and preventing the wood from splitting. The parts are made immovable and irremovable by the process of manufacture, so that the wheel is complete in one piece with no loose plates.

NATIONAL TUBE COMPANY CATALOGUE J—1915, has just been issued. It contains 450 pages, printed in two, and in some places, three colors, embracing in detail the line of pipe fittings, valves and specialties manufactured at the Kewanee Works of the National Tube Company. It also shows in general the other products manufactured by this company. Some idea of the completeness of the catalogue may be gained from the fact that the index embraces approximately 1800 entries. On account of the size of the catalogue it is stated that the edition is limited, the circulation being confined to dealers and other large consumers. The catalogue supersedes the 1909 edition and is published by the National Tube Co., Pittsburgh, Pa.

FISHER POWER PLANT SPECIALTIES, manufactured by the Fisher Governor Co., Marshalltown, Ia., including the Fisher governors and regulating devices for pumps, Fisher reducing valves and pressure regulating devices, Fisher back pressure automatic exhaust and relief valves and other devices, are the subject of a new bulletin catalogue. A few pages at the beginning of the catalogue are devoted to a review of the inventions of William Fisher, the inventor of the governor that bears his name, and it is stated that there was no adequate method of controlling steam pumps previous to his invention. It is more than a third of a century since the first Fisher governor was given to the steam world. The bulletin is accompanied by a special circular featuring the Fisher noiseless back pressure valve, designed to operate in any pipe line position. Size of catalogue 6 x 9 in. (standard), pp. 96.

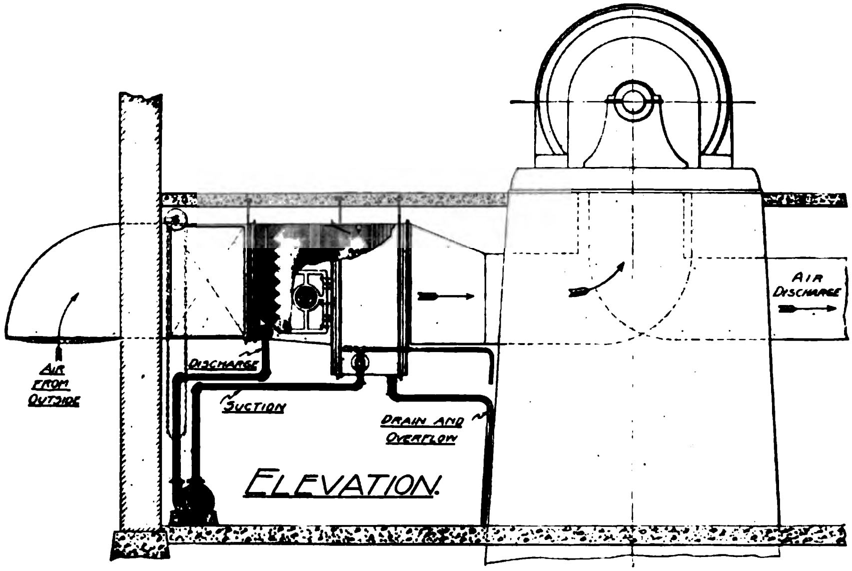
HUMIDITY IN OUR HOMES, featuring the Lockhart humidifying system, invented and patented by John T. Lockhart, Westmount, Quebec, is the subject of a circular outlining the system in detail. The general arrangement may be seen from the accompanying illustraton. The system includes water receptacles located at various points directly beneath the floor. These receptacles are connected by piping to a heater placed in the firepot of any make of furnace. Each receptacle has inlet and outlet openings, causing



SKETCH OF VAPORIZING TANK IN POSITION.

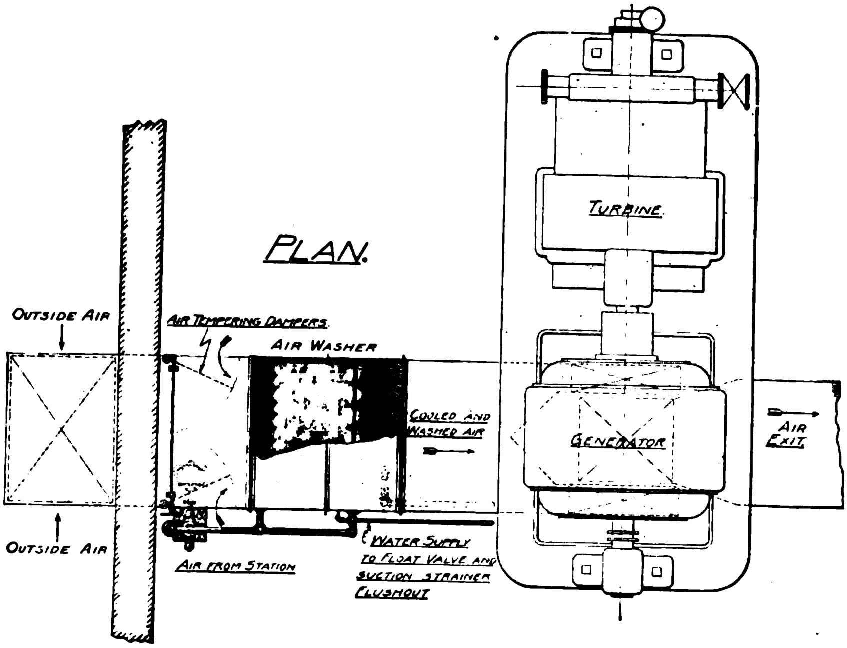
the water to circulate. The system is valved for draining when desired. All of the water receptacles, it will be noted, are made with an air space of 1½ in. at the bottom and ¾ in. at the two sides. The air is brought in from the outside by one pipe and distributed to each receptacle. After the incoming air is heated and moistened by the vapor from the receptacles, it passes up through the registers into the rooms.

PETERSON POWER PLANT OIL FILTER and accessory apparatus for central oiling systems is the subject of an elaborate catalogue pub-



lished by the Richardson-Phenix Co., Milwaukee, Wis. Size 8½x11 in. (standard). Pp. 32.

Washing and Cooling Air for Steam Turbine Generators is an application of the air washers of the Spray Engineering Co., Boston, Mass., which is described and illustrated in a recent catalogue issued by this company. The catalogue gives results of recent tests with Spray air washers, showing cooling results in this connection ranging from 11° F. to 19.25° F., depending on the time of year, but in every case resulting in cooling the air practically to the temperature shown by the wet bulb thermometer. Size 6x9 in. Pp. 8.



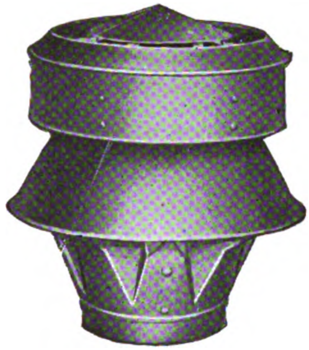
ELEVATION AND PLAN OF AIR-WASHER LAYOUT FOR TURBO-GENERATOR.

SYRACUSE PACKLESS RADIATOR VALVES, giving an interesting history written by Joseph F. Brightman, manager of the incorporation and growth of the Syracuse Faucet & Valve Co., of Syracuse, N. Y., and containing also numerous illustrations of buildings in which Syracuse packless radiator valves are installed, has lately been published by this company. In addition some remarkable letters from satisfied users are presented as evidence of the advantages of this line of valves. The fact that the company is a specialist, making one kind of valve is given as one of the principal reasons for the high development of the Syracuse packless, which is adaptable for vacuum, vapor, hot water, and single and double pipe systems of steam heating. Size 6 x 9 in. (standard). Pp. 24.

RELIABLE VACUUM AND VACU-VAPOR HEATING EQUIPMENT is the title of a catalogue that will be read with much interest by engineers generally, as well as by those more particularly interested in the devices discussed, which are used in the Reliable air line and return line vacuum and vacu-vapor heating systems, manufactured by the Bishop-Babcock-Becker Co., Cleveland, O. Every effort has been made to explain as clearly as possible the construction and function of the different appliances and their action is further illustrated in a series of typical layouts, one showing the air line electric vacuum heating equipment, one, the return line equipment and a third showing the vacu-vapor heating equipment. On other pages sectional half-tone views of the Reliable valves are shown, including the vacustat, vacu-trap, vacu-graduate packless radiator valves, one style of the latter being made with lever handle. There is also shown the Reliable return line electric vacuum pump, which is a recent addition to the company's line, with a maximum capacity of 2,000 sq. ft. of radiation. The catalogue concludes with complete suggestions for specifications covering the three styles of heating. Size 5x8 in. Pp. 96.

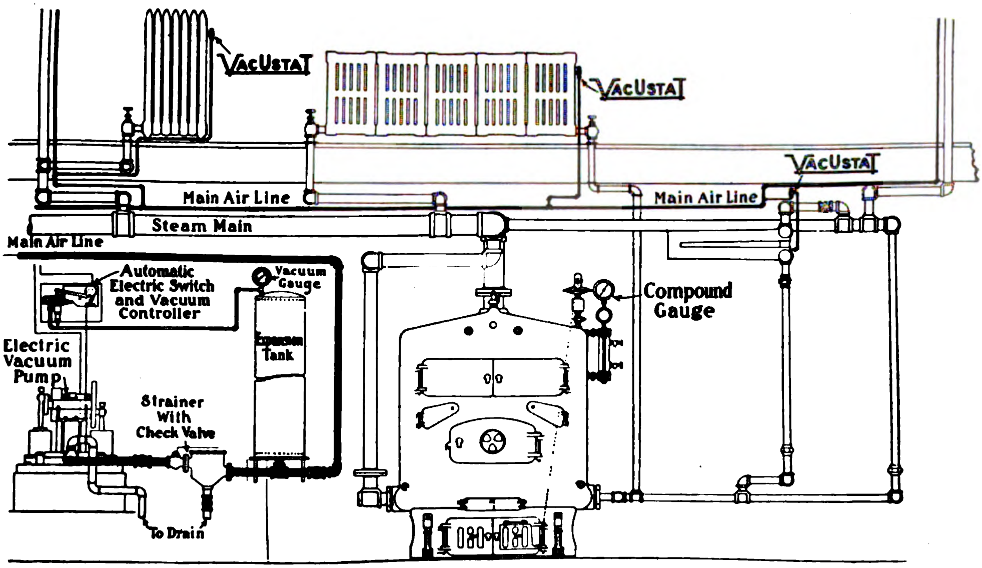
New Automatic Suction Ventilator.

A type of automatic suction ventilator, described as efficient in service, architecural in design and having positively no down draft, has been placed on the market by the Century Ventilating Co., 424-426



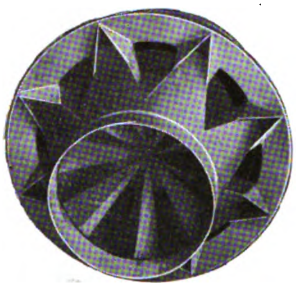
GEM AUTOMATIC SUCTION VENTILATOR.

East 23d Street, New York. It is known as the Gem and is illustrated herewith. One of the points made for this type is that it does not need a higher interior temperature in order to give results, but by



METHOD OF INSTALLING RELIABLE AIR LINE HEATING SYSTEM, WITH A ONE OR TWO-PIPE STEAM PLANT.

reason of its powerful automatic suction, it will displace air trom a building many degrees colder than the exterior atmosphere. The ventilator is made with eight wind conveyors terminating horizontally in a triangular form and leaving like triangular spaces for the passage of the foul air. The wind as it passes through the conveyors tends to form a vacuum in the triangular spaces between the conveyors

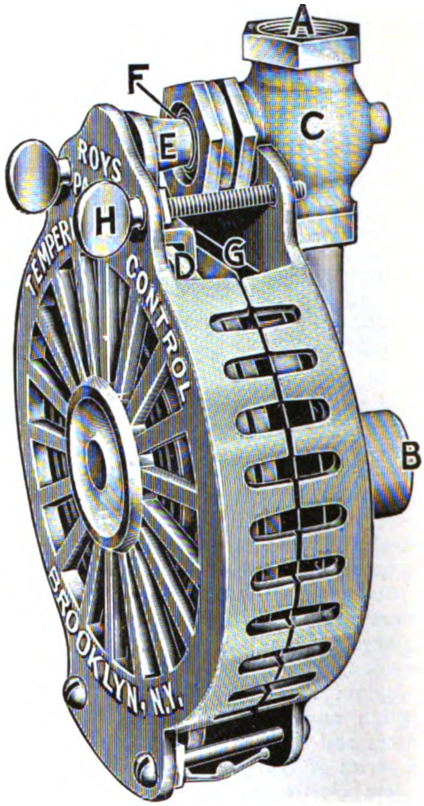


INTERIOR CONSTRUCTION OF WIND CONVEYORS IN GEM VENTILATOR.

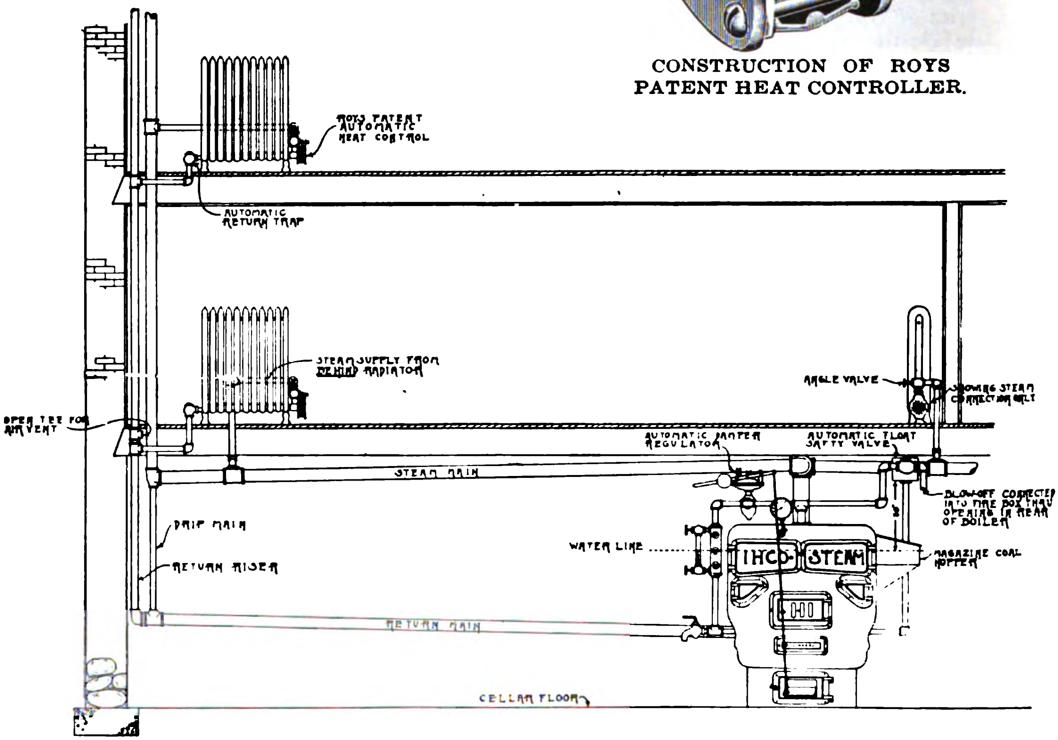
and thus produces an automatic suction. It is made in fifteen sizes, ranging from 8 to 72 in. in diameter.

New Principle in a Heat Controller.

A heat controller, which, when attached



CONSTRUCTION OF ROYS PATENT HEAT CONTROLLER.



— SECTION SHOWING AUTOMATIC HEAT CONTROL SYSTEM — WITH PIPING DETAILS

to a radiator, is designed to automatically open and close the steam supply valve to the radiator so as to maintain a steady, even temperaturė within one degree of any temperature at which it is set, has been brought out by the Roys Heat Control Co., 915 Gates Ave., Brooklyn, N. Y. As will be noted from the illustration, showing a typical layout with this system of control, the arrangement does away entirely with the air valve. Other features of the system include the use of Roys automatic return traps and an automatic safety valve. The use of a magazine feed boiler is also recommended with this system.

The construction of the heat controller will be seen from the accompanying illustration. A is the steam inlet to the controller. B is the steam inlet from the controller to the radiator. C is the valve part of the controller. D is a thermostat compôsed of two corrugated silver discs hermetically united, forming a hollow thermostat. This thermostat is filled with a pressure-exerting gas which acts in such a manner as to expand the thermostat sufficiently to close the steam inlet to the controller at a temperature of 72° F. At 68° it has contracted enough to release the pressure on the valve seat. A spring inside of the valve opens the seat, automatically permitting more steam to enter. E is a boss which presses against the spindle of the valve seat and closes the seat of the valve on pressure from the thermostat. F is a silver corrugated diaphragm which permits the opening and closing of the valve seat. G are non-conductive metal baffles which keep the radiant heat of the radiator from affecting the thermostat by providing spaces for air circulation. H are thumbscrews, which provide means of adjustment to any temperature. By tightening these thumbscrews a temperature as low as 60° F. can be maintained. By loosening the thumbscrews a temperature up to 80° F. can be obtained.

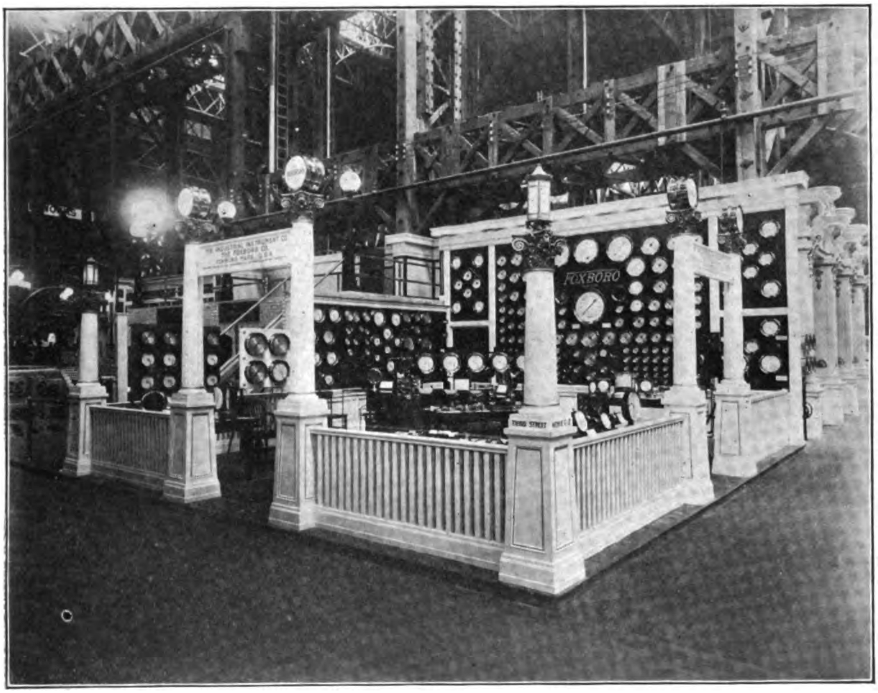


EXHIBIT OF THE FOXBORO COMPANY AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION.

Panama-Pacific International Exposition Exhibits.

2.—The Foxboro Company.

A complete line of indicating and recording instruments for measuring pressure, temperature, speed and time, also automatic temperature controllers and orifice meters, is being shown by the Foxboro Co., of Foxboro, Mass., at the Panama-Pacific International Exposition.

In utilizing recording instrument cases, an attractive light has been designed for the

pillars at the entrances. At the rear of the booth there is a large mahogany panel, on which there are symmetrically arranged "Foxboro" recorders and thermographs, also 170 indicating gauges for pressure and vacuum for every purpose in all sizes from 2 in. to 24 in. in diameter. This is the largest assortment of gauges ever arranged on a single panel for display purposes.

A second attractive mahogany panel at the left side of booth has a display of indicating dial thermometers, round and square case counters, thermographs, recording gauges, recording hygrometers and liquid level recorders; also, an interesting display of the many bulbs, connections and capillary tubing used on this service.

An orifice meter, measuring flow of air, is shown in operation; this is one of the latest developments for accurately measuring the flow of gases and liquids. It is understood that an accuracy of within less than 1% is guaranteed.

At the center of the booth is arranged a frame on which there is an automatic temperature controller, also a recording thermometer, two liquid level recorders, a vacuum recording gauge and a gas pressure recording gauge in operation.

All types of recording gauges for any range, from full vacuum to 20,000 lbs. per square inch, and a very complete line of both indicating and recording thermometers for any range, from minus 60 to plus 800° F. are shown, together with a complete line of electric pyrometers, for any range up to 3,000/ F. or its equivalent.

A. F. Mundy, the company's Pacific Coast manager, assisted by C. E. Sullivan, direct from the works at Foxboro, as well as the company's gas engineer, D. M. Hill, have been active in placing the exhibit in position and the former will be present the entire period of the exposition.

William H. McKiever, New York, engineer and contractor for heating, ventilating and power plants, announces the removal of his offices to the Townsend Building, 1123 Broadway.

ADVERTISERS' INDEX

THE HEATING AND VENTILATING MAGAZINE

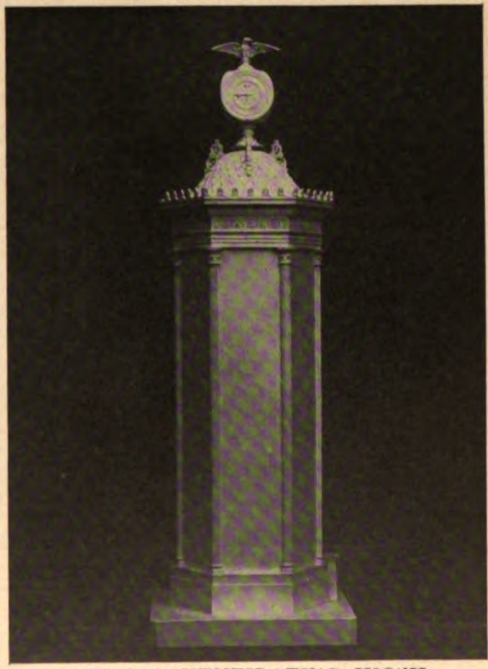
1123 Broadway NEW YORK August, 1915

Subway Ventilation Schemes

Only those who have ridden in a city subway on a hot, humid day can appreciate fully the significance of the agitation that has been started to improve the air conditions of subways in general and in New York City's subways in particular. It is well-known that the present ventilation of the existing subways in New York involves little more than the cleansing and re-circulation of the air. There are, to be sure, sidewalk gratings located between some of the stations which act as air outlets or inlets, as the case may be, depending on the subway air currents caused by the moving trains. The cars themselves are also equipped with ventilating fans which churn the air and give some measure of relief.

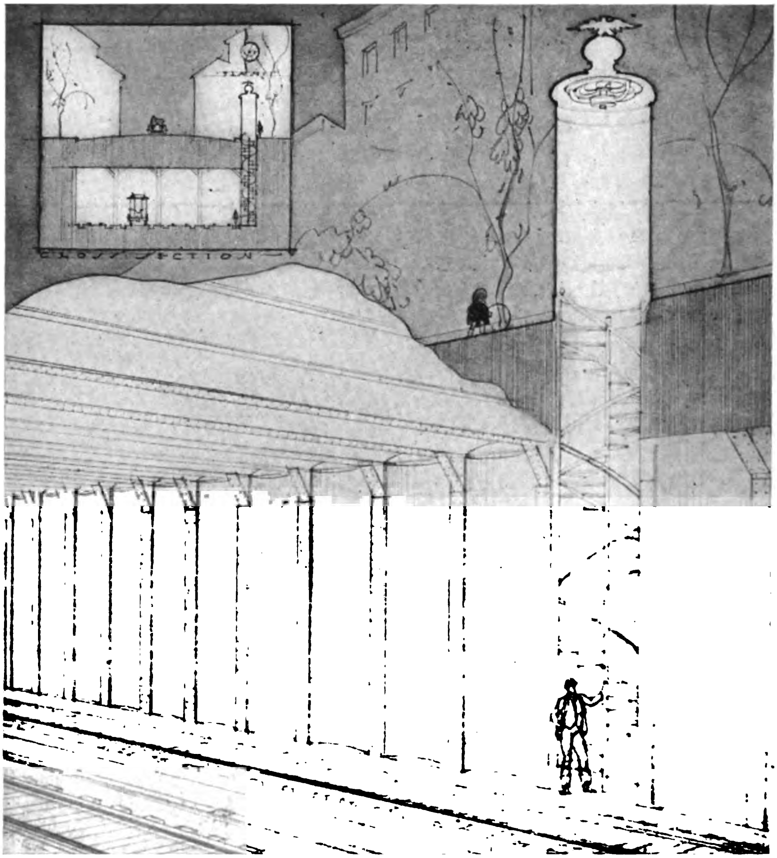
When it comes to the new extensions to the subway, which will involve more mileage by far than all of the existing subways, it seems that little progress has been made to improve on present conditions. The most that has been evolved by the subway's engineers is a system which makes use of sidewalk gratings as air outlets only, provision being made to insure such air outflow through the use of centrifugal fans.

Ever since the news was published that the sidewalk gratings were to be adopted and that they were to be located, in the case of the Broadway subway, at points where there were large numbers of passing pedestrians, especially women, an earnest cry has been raised by Broadway merchants, large and small property owners and hotel residents, protesting against the gratings. Their objections are based on the ground that the gratings are unsightly, dangerous in wet and snowy weather, objectionable in causing large volumes of hot, ill-smelling air to be ejected into the faces of passersby and, finally, in blowing dust and disarranging the clothes of those passing directly over the gratings.


TYPICAL VENTILATING KIOSK.

As a result of the agitation, which took concrete form in the protest of the Broadway Association, made up largely of merchants with establishments on

Broadway, the New York Public Service Commission adopted a resolution authorizing the chief engineer of the commission, Alfred Craven, to request the Interborough Rapid Transit Company and the New York Municipal Railway Corporation to designate their consulting engineers, to act with the commissien's chief engineer, as a board to investigate and report with recommendations upon the question of ventilation for the ways, besides sidewalk gratings were presented. One of the most interesting was a system of kiosk ventilators similar to those of Berlin, Dresden, Munich, Paris, Buenos Aires, Rio Janeiro and other foreign cities. One of the features of the kiosk ventilator is its possible use for advertising purposes. It was stated that the income that could be derived from the yearly rental of the kiosks might run up into hundreds of thousands of

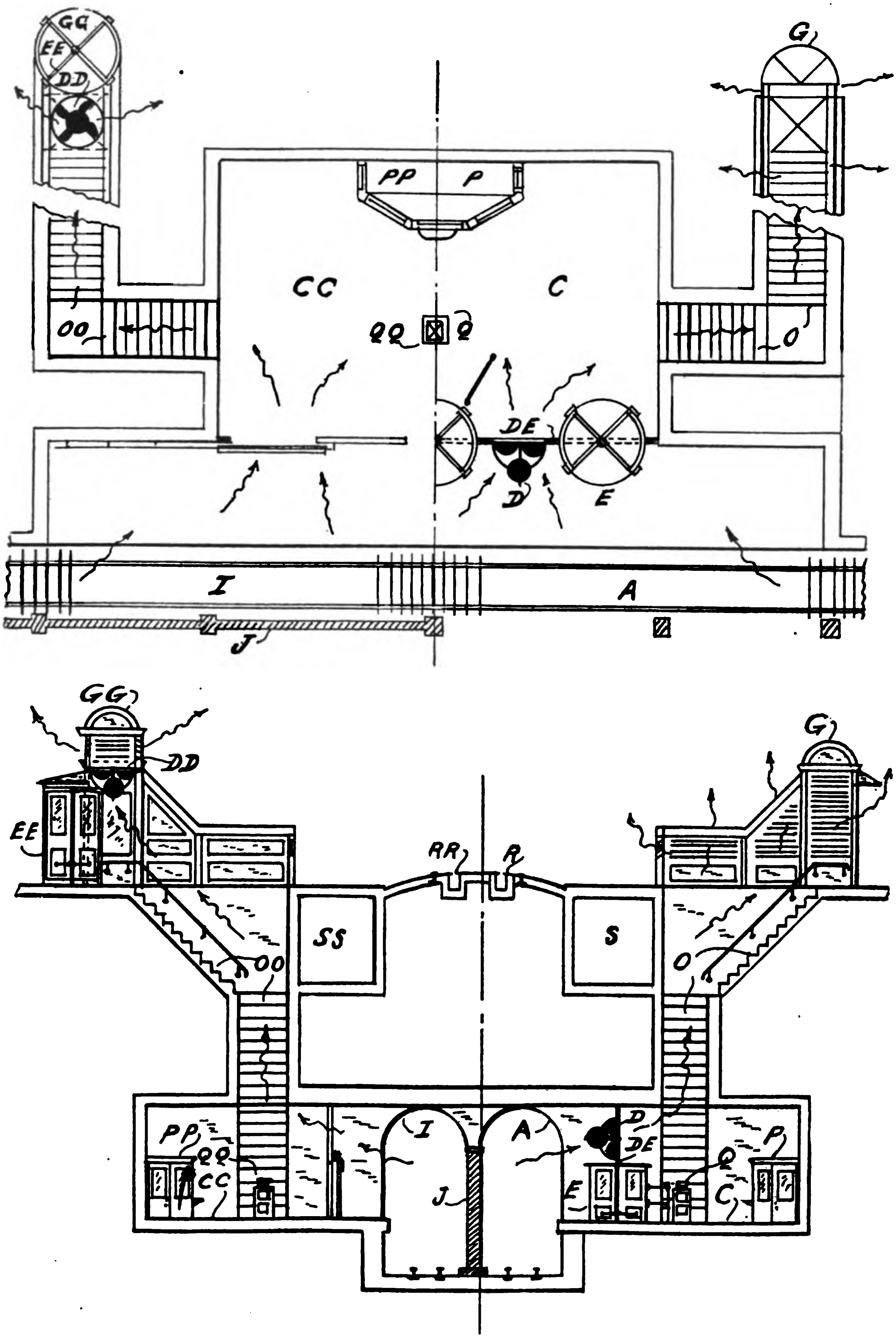


ARRANGEMENT OF KIOSK VENTILATING SYSTEM FOR SUBWAYS.

dual system subways. The consulting engineers for the Interborough company are William Barclay Parsons and S. L. F. Deyo, and those for the New York Municipal Railway Corporation are Jacobs and Davies, Inc., and L. B. Stillwell, of New York.

Arrangements were made for a public hearing on the proposition which was held before the Public Service Commission June 16, last. At this hearing several schemes for ventilating the new subdollars. The only obligation on the part of the city would be the subsurface construction and the granting of a franchise to a company to use the panels of the kiosks for advertising purposes.

The kiosks are of statuary bronze 12 ft. high and 5 ft. wide. They are intended to be placed directly over a duct built to the street level. Being 2 ft. wider than the lateral tunnels of foreign cities, it is planned to put a spiral stairway in the interior for use in case of subway acci-



PLAN AND ELEVATION OF THE SCHEME PROPOSED BY JAMES G. DUDLEY FOR VENTILATING NEW YORK'S SUBWAYS.

dents. When provided with suitable fans, the kiosks are of sufficient size to permit the outflow of 10,000 cu. ft. of air per minute, or as much as can escape from 120 lin. ft. of street gratings in the same time.

With this arrangement the air is drawn up and dispelled over the heads of passing pedestrians. Provision could be made in the kiosk for sterilizing the outgoing air, if desired.

A suggestion regarding the use of the kiosk panels is that one be reserved for the public, with the idea of listing in that space the nearby hotels, names of civic officers, location of public buildings, thermometer, barometer, hygrometer, Government weather reports, etc.

The plan advocated by the promoters is to locate one kiosk on each block. It was pointed out that in foreign cities the kiosks offer the only opportunities for outdoor advertising. In Berlin the annual revenue derived from the use of the kiosks is $95,000.

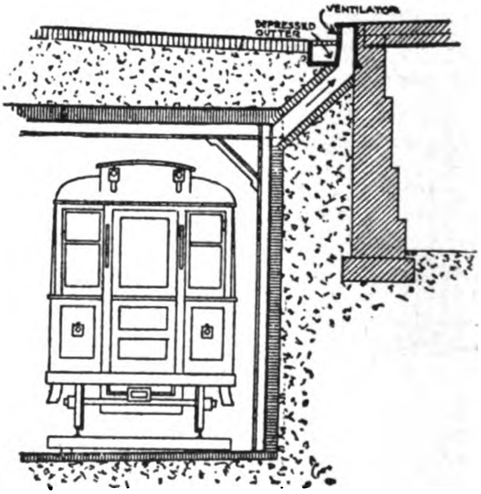
THE DUDLEY PLAN.

Another plan for ventilating the tubes is suggested by James G. Dudley, consulting engineer, of New York. This plan is to seal every other subway station against the intake of air. These will be exhaust stations, the intakes being alternating stations. The stations are to be sealed by revolving doors giving free passage to pedestrians to be built either in a partition at the rear of the station platform and reaching from roof to floor, or at the street entrances and exits. Over the doors will be fans which will draw the air from the tube to the street and well above the heads of the people.

The plan of placing the doors at the street entrances is considered the best. When so placed the fan will be located in the roof of the entrance, the foul air being driven out through apertures in the roof. The air drawn out will necessarily be balanced by the inflow at the next uncontrolled station house, insuring sectional ventilation of the entire subway. The ventilation system is designed to be operated independently of the subway power, the fans being driven by motors located at each station.

THE BOORAEM PLAN.

Another plan and one of foreign origin is the placing of gratings along the side of the street curbs for about 150 ft. on each side of a station. Connecting



HOLLOW OR OPEN CURBED SYSTEM OF VENTILATION.

with the grating is a chimney through which the foul air of the tube is designed to pass. This plan was offered by Robert E. Booraem. It is called the hollow or opened curb system of ventilation. The chimney starts from the side of the subway near to the roof and runs at an angle for 7 ft. to a horizontal duct coming to the sidewalk level. On the road side of the duct is a 10-in. screen through which the exhaust from the subway will meet the free air of the street level. It is the claim of Mr. Booraem that a 10-in. screen or hollow curb for 100 ft. on each side of a street would be equal to an air shaft 14 ins. square.

Operating Data in Connection With Federal Buildings Under Control of the Treasury Department.

By Nelson S. Thompson.

Chief Mechanical and Electrical Engineer, Office of the Supervising Architect, Washington, D. C.

II.

The accompanying table represents the operating characteristics of a large number of Federal buildings in Washington, D. C. These data were gathered in connection with a report made by the writer for the establishment of a central heating, power and lighting plant to serve the buildings noted. Based on the report an appropriation of approximately $1,500,000 was made by Congress to carry out the project.

Certain of the older Federal buildings in the larger cities were not originally provided with isolated power plants, and a few years ago the writer detailed an able engineer to visit these buildings and determine, on the ground, after full conference with the local public service officials, whether the installation of isolated plants would be justified. In one notable instance the situation was especially favorable, and the engineer reported as follows:

Sir:

* * * * * * * * * * *

The following data were obtained from records and conditions at the building to form a basis of data in considering the installation of a plant:

Total wattage of lamps is 377,000.
Total K.W. rating of motors is 700.
Total floor area is 660,000 sq. ft.
Present coal and current consumption—

Month.	Current in K.W.H. Summer.	Winter.	Tons of Coal. Summer	Winter.
July	98,840	......	323.79	......
Aug.	100,340	......	309.35	......
Sept.	105,860	......	319.97	......
Oct.	......	117,240	.....	417.835
Nov.	......	115,590	.....	538.427
Dec.	......	127,080	.....	537.414
Jan.	......	123,970	.....	837.0
Feb.	......	125,800	.....	694.72
March	......	125,800	.....	670.715
April	109,420	......	406.479	......
May	106,430	......	316.392	......
June	116,590	......	269.649	......
	637,480	735,480	1,945.630	3,696.111

	K.W.H.	Tons of Coal.
Summer months	637,480	1,945.63
Winter months..........	735,480	3,696.11
Totals	1,372,960	5,641.74

Current cost per annum, $26,113.35.

$$\frac{26,113.35}{1,372,960.} = \$0.019 \text{ per K.W.H.}$$

Highest maximum demand for any month .... 340 K.W.
Lowest maximum demand for any month .... 225 K.W.
Average hours less than 100 K.W. demand 3,000
Average hours between 100 and 200 K.W. 2,400
Average hours between 200 and 300 K.W. 2,800
Average hours between 300 and 400 K.W. 560

Under the above operating conditions the installation of two 200 K.W. and two 100 K.W. electric generating units would give the most flexible plant and allow ample reserve.

Ample boiler capacity is now installed in the building, and it is believed that better efficiency will be obtained during the summer months with the additional load required by the electric generating plant.

Estimated cost of plant:

Engines and generators.....	$30,000
Piping	2.500
Switchboard changes	1,000
Incidentals	500
Total	$34,000(a)

(a) The plant was installed for $42,000.

COAL.

To be safe and allow 50 lbs. of steam per K.W.H. and a factor of evaporation of 8 1-3 lbs. of water per pound of coal, we would have 6 lbs. of coal per K.W.H., and charging all coal used in six months of the year, and 20% during six months of the seven that exhaust steam is utilized for heating.

637,480x6 = 3,824,880 lbs. of coal
735,480x6x.2 = 882,576 lbs. of coal

4,707,456 lbs. of coal 2,100 tons.
2,100 tons x3.15 = $6,615.00.

ASH REMOVAL.

Ash removal for 5,645 tons of coal costs now $622.41.

Ash removal for 2,100 tons of coal will cost $231.00

WATER.

Water used by the plant will be—4,707,456 lbs. of coal x 8⅓ = 39,228,800 lbs. of water = 627,660 cubic feet x 52.5 cents (per 1,000 cubic feet) = $329.57 per annum.

LABOR.

Present Cost.

1 Chief engineer	$2,200.00
1 Assistant chief engineer..........	1,800.00
3 Assistant engineers	3,600.00
2 Engineer helpers	2,000.00
3 Oilers	2,520.00
7 Firemen	6,387.50
3 Firemen helpers	2,190.00
2 Firemen helpers for 7 months....	852.00
	$21,549.50

With an Electric Generating Plant.

1 Chief engineer	$2,200.00
1 Assistant chief engineer..........	1,800.00
3 Assistant engineers	3,600.00
4 Engineer helpers	4,000.00
4 Oilers	3,360.00
8 Firemen	7,300.00
3 Firemen helpers	2,190.00
2 Firemen helpers for 7 months....	852.00
	$25,302.00

OIL AND WASTE.

Estimated for electric generating plant $300.00

REPAIRS.

$30,000 at 1½%.......................$450.00

INTEREST AND DEPRECIATION.

$30,000 at 10%.....................$3,000.00

Total cost to operate the proposed electric generating plant:—

Coal	$6,615.00
Ashes	231.00
Water	329.57
Labor	3,752.50
Oil and waste	300.00
Repairs	450.00
Interest and depreciation	3,000.00
Total annual cost	$14,678.07
Cost of current during present year	$26,113.35
Estimated cost of current with electric generating plant	14,678.07
Estimated annual saving	$11,435.28

I recommend the installation of an electric generating plant in this building at an early date, as same will pay for itself in three years.

Respectfully,

....

The plant recommended by the engineer was installed after a long controversy, and the writer takes pleasure in stating that after twelve months' operation the annual saving to the Government by the installation of this plant has amounted to $15,984.78 and it is performing its work in a satisfactory manner.

PROCEDURE WHEN CITY HAS CENTRAL HEATING PLANT.

When a Federal building is erected in a city where a district heating company has steam or hot water mains in the vicinity, the heating apparatus is designed so that the building may be operated either by its own boilers (which are always installed) or by the heating medium purchased from the district heating company. Upon receipt of the company's proposal for supply of the heating medium, which in the case of steam is nearly always based on a sliding scale so arranged that the price per thousand pounds decreases as the amount used per month increases, it is necessary for the office to determine accurately whether it will be more economical to generate its own steam or to purchase the steam from the company. The following method is used:

The actual amount in square feet of direct radiation is taken off the plans, to which is added any fan blast surface and any gravity indirect surface. To reduce to equivalent direct radiation the amount of blast coil surface in square feet is multiplied by 3, and the gravity indirect is multiplied by 1½. The equivalent direct radiation is then assumed to condense during the 212 days of the average heating season 500 lbs. of steam per square foot. To apply the sliding scale the total steam per season is apportioned as follows:

Oct. 1 to Oct. 31	5% of total
Nov. 1 to Nov. 30	15% of total
Dec. 1 to Dec. 31	20% of total
Jan. 1 to Jan. 31	25% of total
Feb. 1 to Feb. 28	15% of total
Mar. 1 to Mar. 31	15% of total
Apr. 1 to Apr. 30	5% of total

The total cost is thus ascertained if steam be purchased, and it is compared on the following basis with the cost of operating the boilers in the building:

The total number of pounds of steam per annum as previously ascertained is divided by 7, which gives the number of pounds of coal per annum used under the boilers. This is reduced to tons and the local cost per ton of coal is applied. To the actual cost of coal is added the cost of ash removal, which is taken roughly as 10 cents per ton of coal, and in the infrequent cases (especially in the smaller buildings) where labor can be saved by the purchase of steam the cost of the additional labor is added. The department is usually willing to pay $100 or over per annum more for the purchase of steam in order to be relieved of the operation of the boilers, to secure freedom from smoke, dirt, etc.

If hot water is the medium the same process is used, by reducing the hot water radiation to a steam equivalent (dividing the hot water radiation by 1.6) to ascertain the amount of coal to be burned and compare it with the flat rate always quoted for hot water radiation by the local companies.

South of the Mason and Dixon line the figure 500 above noted will become 450, while in San Francisco, Cal., it will approximate 350 lbs. per square foot direct steam radiation.

The majority of the buildings are very small, and the mechanical equipment consists of a direct steam or hot-water heating apparatus and a gas and electric direct lighting system supplied with either gas or electricity from local companies. In these small buildings the matter of engineering personnel, purchase of supplies, fuel, etc., is merely routine.

It was the practice of the department

OPERATING CHA

BUILDING	BOILERS		ENGINES		GENERATORS		MOTORS		LIGHTING	CONTENTS IN CUBIC FEET
	NUMBER	TOTAL RATED HORSE POWER	NUMBER	TOTAL RATED HORSE POWER	NUMBER	TOTAL RATED KILOWATTS	NUMBER	TOTAL RATED KILOWATTS	NUMBER of 16 c.p. LAMPS or EQUIVALENT	
BUREAU ENGRAVING AND PRINTING (Old)	7	1250	4	1300	4	1060	914	800	10,000	5,000,000
BUREAU ENGRAVING AND PRINTING (New)	—	—	—	—	—	—	1086	969	13,600	7,000,000
DEPARTMENT OF AGRICULTURE	8	1125	1	150	1	100	137	350	2845	3,500,000
WASHINGTON MONUMENT	2	160	1	80	1	50	small	amount	Small	
STATE, WAR AND NAVY DEPARTMENTS	4	740	3	525	3	350	27	205	4000	7,053,500
WINDER BUILDING	4	240	—	—	—	—	—	—	800	600,000
MILLS BUILDING	2	200	2	250	2	125	16	160	1000	750,000
COURT OF CLAIMS	2	50	—	—	—	—	—	—	275	600,000
WHITE HOUSE	W 2 S 2	100 130	—	—	—	—	10	23	2400	2,000,000
TREASURY DEPARTMENT	W 6 S 5	600 560	—	—	—	—	20	120	5000	6,250,000
DISTRICT BUILDING	4	600	3	420	3	375	21	130	3000	4,600,000
POST OFFICE DEPARTMENT (Pa. Av. & 12th St.)	12	1200	4	1000	4	480	20	85	5000	8,450,000
NATIONAL MUSEUM (Old)		Supplied by National Museum (New)								
NATIONAL MUSEUM (New)	4	900	4	700	4	525	75	240	⓪7850	8,000,000
SMITHSONIAN INSTITUTE		Supplied by National Museum (New)								
ARMY MEDICAL MUSEUM	LP 4 HP 1	200 25	—	—	—	—	1	3	300	1,500,000
FISH COMMISSION	1	35	—	—	—	—	2 1	15 2	90	300,000
TOTALS	70	7915	22	4425	22	3065	2380	3102	56160	55,603,500

"W"—WATER BOILER—BOILERS ARE STEAM UNLESS OTHERWISE NOTED "LP"—LOW PRESSURE "HP"—HIGH PRESSURE
⓪—SUBJECT TO AN INCREASE OF 4000 IN 2 YEARS

ESTIMATED EQUIPMENT AND OPERATING FACTORS OF

BUILDING	BOILERS		ENGINES		GENERATORS		MOTORS		LIGHT
	NUMBER	TOTAL H.P. RATED	NUMBER	TOTAL H.P. RATED	NUMBER	TOTAL K.W. RATED	NUMBER	TOTAL K.W. RATED	NUMBER 16 C.P.
DEPT. OF JUSTICE	3	400	3	450	3	300	12	240	4480
DEPT. COMMERCE & LABOR	6	850	4	1000	4	750	24	520	14000
DEPT. OF STATE	4	500	3	600	3	450	20	400	6800
TOTALS	13	1750	10	2050	10	1500	56	1160	25280

ırchase coal on the B. T. U. basis for ›uildings where the cost exceeded)0 per annum, but this method of ıasing has been discontinued except ıe large buildings.

ıen coal is purchased under the B. system the specifications state what of coal is desired, and limit the ıt of volatile matter and ash which e permitted.

h bidder offers such coal as he will meet the specification, and n his proposal the following infor- ı relative to the coal he proposes ply:

ıber of B. T. U. per pound of dry received.

entage of ash per pound of dry

per ton of coal.

here is always a variation in the ntent of coal offered by the vari- dders, it is necessary, in order to all to the same basis, to fix a d ash content and make an allow- r variation from same.

lowest ash content stated by any is made the standard, and all other brought to this basis by adding 2 er ton to the price quoted for each cent. or fraction thereof the ash t exceeds the arbitrary standard.

n all proposals have been brought same basis in regard to ash content, west price quoted per 1,000,000 U. is readily ascertained by the fol- g formula: Cost per million B.

$$= \frac{1{,}000{,}000 \times \text{price per ton of coal}}{2{,}240 \times \text{B.T.U. per pound of coal}}$$

When the coal purchased under the B. T. U. system is delivered at the building samples are taken and sent to the Bureau of Mines for analysis, the result of which determines the payment to be made for the coal delivered. If the analysis shows that the contractor has fulfilled his agreement, no more and no less, the contract price is paid; otherwise, corrections above or below the contract price are made for variation in B. T. U. and ash.

The correction for B. T. U. is made by the following formula:

$$\frac{\text{Delivered B. T. U.} \times \text{contract price per ton}}{\text{Contract number of B. T. U. per pound}} = \text{price paid per ton.}$$

For example: If the contractor stated that his coal contained 14,000 B. T. U. per pound and the price per ton was $3, and the coal delivered contained 14,300 B. T. U. per pound, he would be paid per ton

$$\frac{14{,}300 \times 3}{14{,}000} = \$3.0643$$

The price to be paid must be further corrected for any variation in ash content. For all coal, which by analysis contains less ash than that established in the proposal, a premium of 2 cents per ton for each whole per cent less ash is paid. An increase of 2 per cent. in ash over the contract amount is tolerated without deduction, but for any excess a penalty is exacted in accordance with the following table:

s es- shed osal r cent.	No deduction for limits below	Cents per ton to be deducted: 2	4	7	12	18	25	35	Maximum limits for ash
		Percentages of ash in dry coal							
....	7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	12
....	8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	13
....	9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	14
....	10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	14
....	11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	15
....	12	12-13	13-14	14-15	15-16	16-17	17-18		16
....	13	13-14	14.15	15-16	16-17	17-18	18-19		16
....	14	14-15	15-16	16-17	17-18	18-19	19-20		17
....	15	15-16	16-17	17-18	18-19	19-20	20-21		18
....	16	16-17	17-18	18-19	19-20	20-21	21-22		19
....	17	17-18	18-19	19-20	20-21	21-22			19
....	18	18-19	19-20	20-21	21-22	22-23			20
....	19	19-20	20-21	21-22	22-23				21
....	20	20-21	21-22	22-23					22

When local conditions permit the choice of either gas or electricity as the illuminating medium, preference is given to electricity for many practical reasons, such as maintenance, adjustments, etc., and on account of the great amount of heat generated by the gas, which is a decidedly objectionable feature during the summer months.

With combination lighting fixtures designed to give satisfactory illumination using either tungsten lamps or Welsbach gas lamps, the cost of illuminating a building will be about the same for gas and electricity if gas is selling at $1 per thousand cubic feet and electricity at 10 cents per kilowatt-hour. The theoretical ratio of cost based on *equal* illumination is approximately 30 to 1 on the basis that 1 watt of electricity will give 10 lumens on an average and gas 300 lumens per cubic foot on an average, but actual experience has demonstrated that the true ratio is 10 to 1, under practical operating conditions as found in Federal buildings.

Where conditions permit the use of either gas or electricity their relative costs are carefully analyzed in each case, on the assumption that the full connected lighting load of a building will be in service 1,200 hours per annum. The following data are used in connection with the gas lighting:

Pilot uses 1/15 cu. ft. of gas per hour and burns continuously.

Welsbach inverted No. 4T uses 1.6 cu. ft. per hour and gives 450 lumens. No. 3T uses 2½ cu. ft. per hour and gives 900 lumens. Junior upright uses about 1¾ cu. ft. and gives 350 lumens. Inverted No. 20 uses 9 cu. ft. per hour, and gives 2,400 lumens. Welsbach inverted No. 1 uses 3½-4 cu. ft. per hour and gives 400 lumens. Welsbach upright gallery burner uses 4½ cu. ft. per hour and gives 800 lumens.

Records for Two Factory Buildings and a Y. M. C. A. Building

By S. R. Lewis.

Following are the data presented by S. R. Lewis in the course of his address as president of the American Society of Heating and Ventilating Engineers at its recent annual meeting, on the operating costs of the heating plants in three typical buildings:

In 1912 two large factories were designed by the same architects, one in Toledo and one in Detroit. The writer designed the heating equipment for both plants.

The character of the construction is identical. There are no basements, but there are some tunnels provided under the first floors for air ducts, service pipes, wiring, etc. The buildings are of reinforced concrete construction with solid concrete floors, mushroom type, and 12 in. brick curtain walls. The glass is set in tight, steel frames extending practically from floor to ceiling, and from column to column. The ratio of glass to exposed wall is approximately three to one. The roof is a concrete slab with a cinder fill and tar above.

The Toledo building is heated and ventilated by an all indirect system, equipped with automatic temperature and humidity control, the humidifying being by means of steam jets. There is direct radiation whatever, except in a a few toilet and service rooms.

The Detroit building is heated entirely by direct radiation, about one-half of the radiation being placed on the side walls and one-half on the ceiling. Great care was taken, however, in placing the radiation on the side walls to provide for a very liberal circulation of air behind it. The Detroit building has no automatic temperature control, although good hand regulation is obtainable by shutting off parts of the radiation.

Both plants are equipped with efficient, two-pipe, vacuum systems.

The Toledo plant is unique in its design to the extent that the blast heating surface is arranged at the bases of the vertical flues and so proportioned that much the same effect is obtained every day as would be obtained by having direct radiators in the various rooms, since gravity indirect heating is always in effect whenever there is any steam in the radiation. The theory in the design was that the Toledo plant should be economical, comparing with direct radiation by reason of this gravity effect, while not open to the objections inherent with direct radiation when placed against the outside walls. These objections are that the direct radiation interferes with the benches of the workmen, causes local overheating, and is not economical of fuel, since there is an opportunity for a large amount of radiant heat to enter directly the outside wall without appreciably affecting the temperature of the room. The air is handled by steam power, and the cost of air handling is included in the fuel cost.

The Detroit plant, with its direct radiation, is, of course, heated whenever supplied with steam.

In order that some idea may be obtained of the relative costs of operating the two plants, a careful record was made of the fuel consumed during the season of 1913-14.

The following is the governing data:

	Toledo with ventilation.	Detroit no ventilation.
Exposed glass surface...	39,520*	18,980*
Exposed wall surface.....	7,904*	2,796*
Exposed concrete column surface	7,680*	2,796*
Exposed roof surface.....	45,880*	3,600*
Exposed ground floor surface	45,500*	3,600*
Contents	2,460,500†	704,592†
Floor area	178,800*	56,955*
Blast radiation	12,983*	
Direct radiation	negligible	8,905*
Air delivered per minute.	138,000†	
Boiler capacity	500‡	125‡
Cost of coal per season...	$3,009.00	$952.00
Fuel cost for heating and ventilating per 1,000 cu. ft. of contents per season	$1.22	$1.35
Same per thousand sq ft. of floor space per season	$16.82	$16.73

*Square feet.
†Cubic feet.
‡Horse power.

So far the evidence is favorable to a blast system as indicating that a large, well built, factory building can be heated and ventilated with an efficient, all indirect plant for less cost per thousand cubic feet of space per season and for nearly the same cost per thousand square feet of floor space, per season, as it can be heated alone for by plain direct radiation.

GREATER HEIGHT OF TOLEDO PLANT FAVORABLE TO FUEL ECONOMY.

Such a conclusion on the data given is not fair, however, and the reason for the apparent greater economy of the Toledo plant lies in the more economical construction of the building; that is, the Detroit building being but two stories high loses heat through the floor of the first floor and through the ceiling of the second floor, whereas the Toledo building, being four stories high, has two intermediate stories which only lose heat around their edges. This advantage is sufficient in the instance under consideration to make a favorable showing for the blast system.

If, however, we compare the cost per hundred thousand heat units lost per hour (from the theoretical computations using the same factors for each building for zero outside) we find that the Toledo plant cost 65 cents where the Detroit plant cost but 42.8 cents.*

It is apparent that owners should consider more earnestly than is apparently their custom, the effect of cold exposure in heating cost.

I believe we can conclude fairly that an increase of 35 per cent. in the fuel cost of heating alone for the addition of good ventilation, is a justifiable expenditure and that the difference in price will prove to be more nearly 35 per cent. than 100 per cent. as is often loosely stated.

The following extracts are made from letters written by the owner of each building in March, 1914, in order to show that both plants were heating the buildings adequately and satisfactorily:

TOLEDO.

"Our tenants are very enthusiastic over the heating conditions of the building. The building has been at 70° at 7 o'clock each morning throughout the heating season when the outside tempera-

*Editor's Note.—In the ensuing discussion of this address, at the suggestion of M. W. Franklin, Mr. Lewis coined the term "cost per 100,000 heat unit years" as a convenient way of expressing the cost of heating a building for an entire year on the basis of the B. T. U. used.

tures during the day-time have been as low as 3 and 4° below zero.

"We have yet to have any complaint from any of the tenants about the building being insufficiently heated. Indeed about a month ago, during the severe cold weather, we made a test of the conditions immediately next to the glass surfaces of our most exposed room—the temperature in the center of the room was 70°; the temperature one foot from the glass was 60°."

DETROIT.

"Our heating system, we are very glad to say, has proven quite adequate to take care of us in the severest weather. As to advising whether the two floors equalize in radiation, this we have not followed very closely. There has been no complaint and it would be probably hard for us to determine, as we have a number of firepots on our main floor and the heat from these would probably make some little difference."

The Detroit plant makes automobile radiators and sheet metal accessories.

When buildings are heated by central station steam systems, it is easy to determine the cost of heating them. At Aurora, Ill., the Y. M. C. A. building, heated continuously, of a reasonably good character of construction, gives us the following information:

The plant cost for heating, on the basis of a sliding scale price for steam, as follows—winter 1912-13:

		Percentage of total each month.
October	$ 43.12	6%
November	77.52	13%
December	84.36	14%
January	140.22	23%
February	100.32	18%
March	90.20	15%
April	57.62	9%
May	14.63	2%
Total	$607.99	100%

The total heat loss per hour is 608,000 B.T.U. computed for an outside temperature of 10° F. $\frac{608,000}{966} = 639$ lbs. of water per hour.

If the season were cold throughout, we would theoretically require (24 hours per day) × (210 heating days) × (639 lbs. per hour) = 3,220,560 lbs. of steam per season. The plant did condense 1,013,720 lbs. of steam, as of course the maximum condensation occurred but a very small part of the total time.

We may apparently safely deduce from this that instead of figuring arbitrarily 16 hours per day, as is a general custom, instead of 24 hours per day, we can figure the 24 hours and then multiply the result by a percentage. This percentage for the latitude of Chicago is $\frac{1,012,720}{3,220,560} = 31.4$, say 32 per cent.

By using the monthly percentages given above, the cost of heating for any month is obtainable after the total season cost has been computed.

The theoretical loss from the building was based on the following general factors, without any percentages added for points of the compass or leakage.

"K" constant for 1 sq. ft. of various building exposure surfaces, representing the B.T.U. loss per hour per degree difference between the inside and outside temperatures:

BRICK WALLS:

Furred (K).	Bare (K).
8 in.—0.46	8 in.—0.23
12 in.—.0.33	12 in.—0.21
16 in.—0.27	16 in.—0.19

Cement floor on ground, K = 0.31.

Top floor ceiling with shallow attic, K = 0.15.

Single window, K = 1.20.

Single skylight, K = 1.50.

These are published, more elaborated, by the American Blower Co. of Detroit.

A Pressure Survey Study Constituting a Report on the Comparative Use of Exhaust and Live Steam for Heating

By C. C. Wilcox.
Engineer Hodenpyl, Hardy & Co., Jackson, Mich.

The investigation, of which this is a report, has grown out of a series of experiments carried on by the Central Illinois Light Company, under the general supervision of the writer and under the direct supervision of G. C. Daniels. These experiments were originally started with the idea of making an analysis and study of the pressure conditions in the Peoria, Illinois, steam heating system.

For the most part, a complete system of records is kept, which shows all of the principal operating details, in regard to the heating system; but in addition to these records, a number of days have been selected for the taking of the additional data, which would determine quantitatively the benefit derived by the reduction of station pressure, caused by the installation of additional pipe line capacity

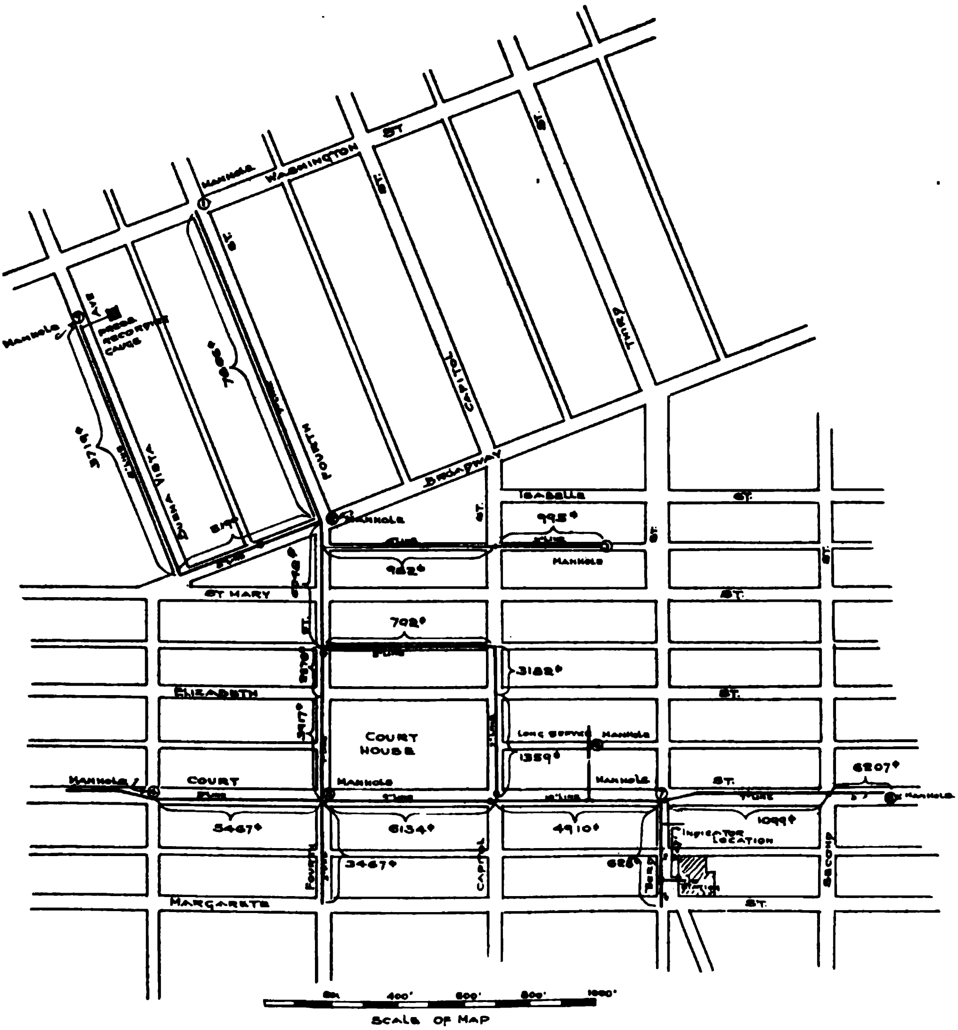


FIG. 1.—CENTRAL PORTION OF PEKIN, ILL., SHOWING POWER HOUSE AND HEATING MAINS.

from the station. Before proceding very far with this work, it was found that so many variables existed that certain of them should be studied more in detail. One of these conditions was the relative effect upon the pressure in the system experienced by the use of live or exhaust steam; and in order to investigate this particular phase of the subject more thoroughly, the Pekin, Illinois, heating system was selected as the one most favorable to this work.

This property is about ten miles down the Illinois River from Peoria, and is connected to Peoria by an electric transmission line. Ordinarily the heating load is "floated" on the transmission system, i. e., just enough current is generated in the Pekin power station to furnish sufficient exhaust steam to meet the demands of the heating system.

Fig. 1 is a map of the central portion of Pekin, showing the location of the power station, with reference to the heating system, and to the center of the town, which is located principally on the four sides of the courthouse square.

At the time these tests were run, there was connected to the system 60,174 sq. ft. of heating surface, giving a heating surface in mains of 12,696 sq. ft. The cubical contents heated was 4,355,744; number of services, 101; square feet of pipe surface in services, 4,692.

The system consists entirely of wood-log and variator construction.

Fig. 2 shows the arrangement of the power station building. The proper location of all of the units of apparatus is shown, but the piping diagram is slightly re-arranged in a schematic manner, in order to make the connection more easily followed.

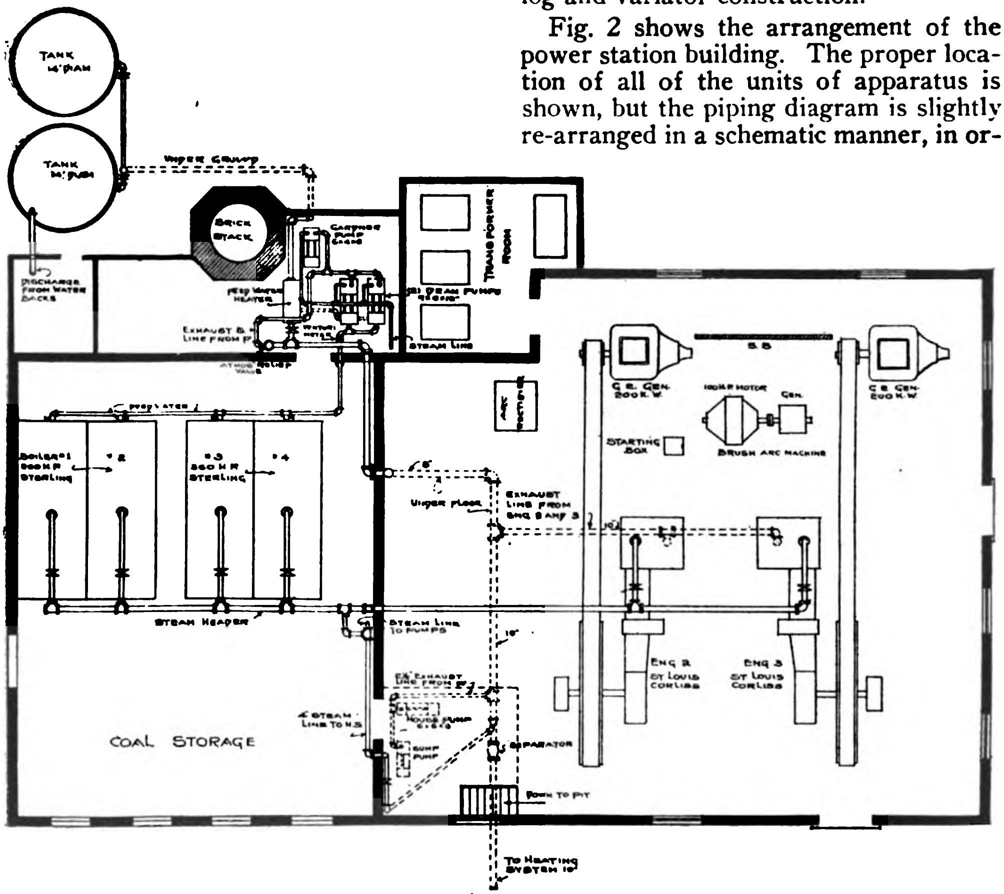


FIG. 2.—ARRANGEMENT OF POWER STATION AT PEKIN, ILL.

Engine No. 1 is not shown, as this engine is not connected up. Engines 2 and 3 are the ones used for supplying heat to the heating system, and are St. Louis Corliss engines, size 22x42, running at

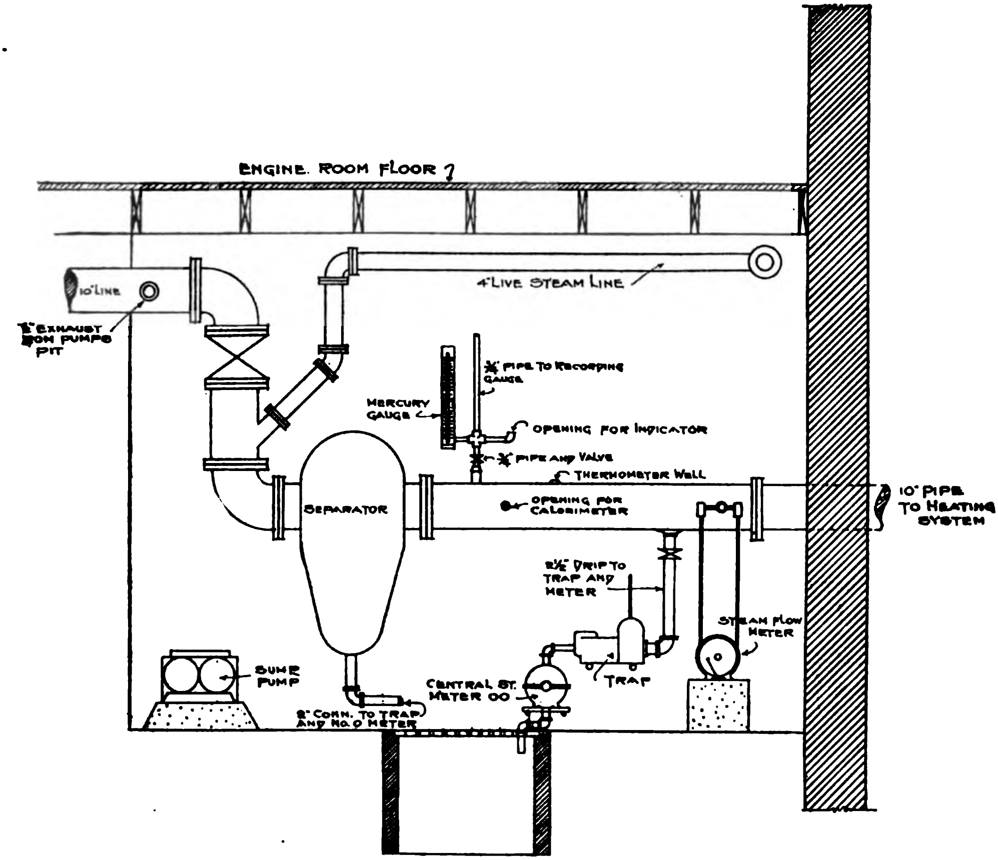


FIG. 3.—ELEVATION OF PIT IN BOILER ROOM CONTAINING DUPLEX PUMPS, CALORIMETER, ETC.

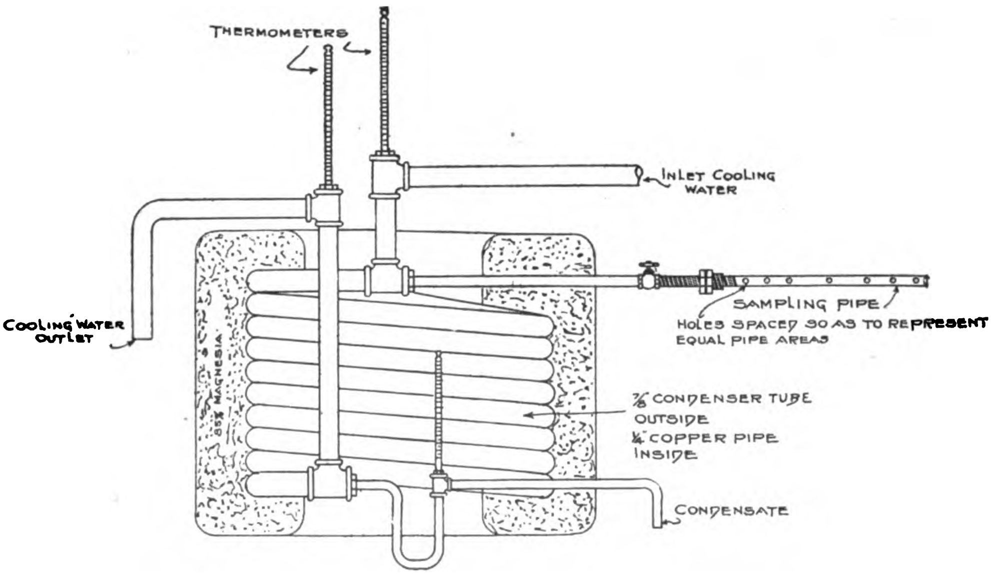


FIG. 4.—CROSS SECTION OF CALORIMETER USED IN TESTS.

83 R. P. M. They are belted to A. C. generators. They are rated at 300 h.p. at 100 lbs. of steam at the throttle.

In the engine room basement, next to the boiler room wall, is shown the pit, in which are located two duplex pumps. It was in this pit that the calorimeter and other apparatus used during the tests, was located.

Fig. 3 is an elevation of the pit referred to in the paragraph above, and shows the general arrangement of the apparatus used during the tests. For the sake of clearness, the calorimeter has not been shown in this drawing, but a separate drawing has been prepared for it.

Fig. 4 shows a cross section of the calorimeter which was used for determining the quality of the steam going out to the heating system. This calorimeter consisted of two concentric tubes, the outer one being a 7/8-in. condenser tube, and the inner one a 1/4-in. copper pipe. The cooling water circulated through this coil between the 1/4-in. pipe and the condenser tube, the steam passing through the 1/4-in. pipe. The temperature of the cooling water was measured as it entered and as it left the coil, and the temperature of the steam was taken as it entered and as it left the coil. A "U" bend was placed in the outlet for the steam condensate to keep the thermometer bulb submerged.

The calorimeter was located as closely to the 10-in. heating main as possible, and was thoroughly lagged, both inside and out of the coil, with 85% magnesia covering. The steam connection from the heating main to the calorimeter was also thoroughly covered.

The holes in the sampling pipe, which was used to collect the steam samples for the calorimeter, were spaced at unequal distances apart, these distances being calculated so that each one represented a certain equal area of the pipe, the cross-section of the pipe being divided by a number of imaginary concentric circles making equal area divisions. The sampling tube was placed in the steam pipe horizontally.

The cooling water entering the calorimeter was caught and weighed in a barrel. The steam condensed in the calorimeter was also collected and weighed; and from these weights, in connection with the temperatures of the incoming and outgoing cooling water, and the steam temperatures, the quality of the steam going to the heating system was calculated.

The flow of steam to the heating system was taken by a General Electric Company's type F steam flow meter. The pressure of steam in the heating main was taken by a recording pressure gauge, which was checked by a mercury gauge.

The heating main leaving the station drains backward to the station, so that it was thought necessary to install a drip connection to prevent condensed steam from flowing backward in the pipe and vitiating the calorimeter readings, and the readings of the moisture removed by the separator. A trap and meter, as shown in Fig. 3, were placed on this drip connection, and readings of this meter were taken during the test. It was found, however, that no condensation was returned to the station through this drip connection.

The opening for the calorimeter was placed as close to the separator as practicable, in order to find a location in the pipe where the steam was agitated as much as possible, in order to secure an average sample. It is thought that in this way it was impossible for any large amount of condensation or moisture in the steam to precipitate to the bottom of the pipe after it had passed the separator, and before it came to the sampling pipe and to the calorimeter.

In order to determine how great the pulsations in pressure were at the station, an indicator was located on the pressure connection, as shown in Fig. 3, and cards were taken at this point with a 4-lb. spring. In Fig 5 is shown the result of this test. Curves a, b, c and d.

This indicator was then taken to a point about 250 ft. from the station, on the first service taken off from the steam main, to see whether the variations in pressure resulting from the engine pulsations were carried for any distance along the main. The results of this test are also shown on Fig. 5. Between these two stations where indicator cards were taken, i. e., at the power house and at the first service, there was 200 ft. of 10 in. pipe as steam main, and 47 ft. of 2 1/2 in. pipe as service. It is to be noted that almost no fluctuations in pressure could be

detected at the service, with the engines either in or out of step. On the first curves shown in Fig. 5, the amplitude of these pulsations varies from a small quantity to a maximum of about ¾-lb. This is due to the fact that the engines are belted to generators, and due to the difference in belt slippage, the engines gradually pass into and out of periods of synchronism. The variations of pressure due to these pulsations, as recorded by the indicator at the end of the service, were so small that no difference could be detected between the conditions of the engines being in synchronism or out of synchronism, consequently only one curve is reproduced (Curve e).

It was the intention to measure the pulcations in the *flow* of steam under these conditions—i. e., to determine if the *velocity* of steam leaving the station varies the same as the pressure, and also if this variation in the flow of steam is carried out into the pipe. It is thought, however, that the almost entire absence of any pulsation in pressure, at so close a distance to the power station, would indicate that the flow of steam is sensibly uniform throughout the system; at least, does not vary according to the pulsations produced by the engine exhaust.

PRINCIPAL RESULTS TAKEN FROM TWO TESTS.

The principal results presented herewith are taken from two tests, made on March 1 and March 2, 1915, to determine the difference in various results incident to the use of live and exhaust steam. The two days chosen were almost identical in weather conditions, as is shown by the temperature, relative humidity and wind velocity. Both days were sunshiny and so far as is known, the conditions throughout the heating system were identical. A large number of tests had been made previous to these days, but it was very difficult to find two consecutive days in which the weather conditions were identical, and on which the tests could be carried out without interruption of any kind. The two days chosen were rather remarkable in that respect and are the only days for which the results are reproduced. The results of these two days' tests are shown in tabular form.

The Send-Out Analysis shown at the end of this table is not intended to be a strict heat balance, but was calculated principally to show the distribution of steam under the two different conditions. In this connection, attention is called to the fact that the total B. T. U. sent to the heating system above feed water temperature in the two cases is very nearly the same, being 77,071,000 in cases of exhaust steam, and 74,661,000 in the case of live steam. It is also to be noted that the per cent. heat unaccounted for is greater in the exhaust steam run than in the live steam run. This can be mostly accounted for by the greater amount of piping involved in the test, and the consequent greater possibility for leakage, etc. In this analysis, the heat sent to the heating system was calculated above boiler feed water temperature. This temperature was taken for several reasons—it is a measure of the performance of the

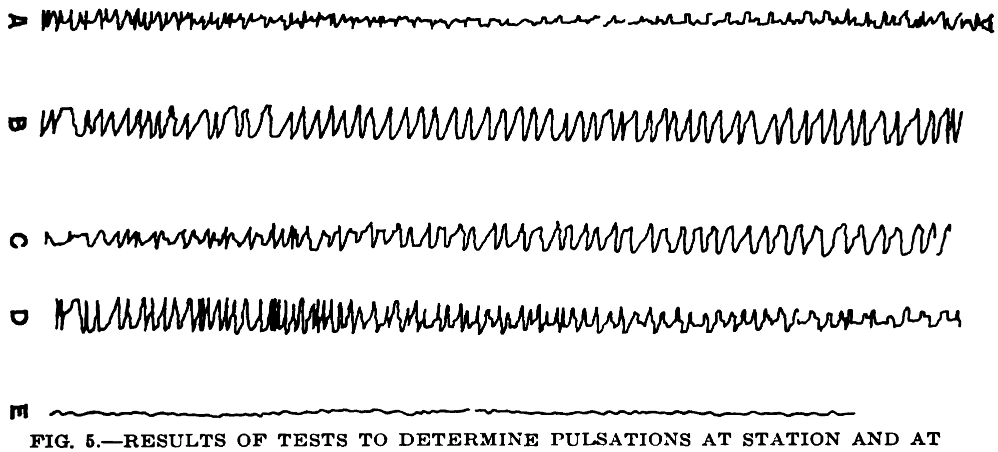


FIG. 5.—RESULTS OF TESTS TO DETERMINE PULSATIONS AT STATION AND AT A DISTANCE OF 250 FT.

boilers, and at the same time is approximately the temperature at which the steam is discharged from the customers' installations.

The figure of 4 per cent. moisture, used in the calculation of the test, is the average of fifteen determinations taken on various days. In these tests, the temperature of the entering and leaving cooling water remained practically constant, showing that the moisture remained constant. The variations in the results are due to the inability to read the temperature and weight closely enough, with the apparatus which was used. An error of 1 per cent. in the weight of the condensate or cooling water or any of the temperature readings, results in an error of slightly over 1 in the quality expressed in per cent.

The figure of 4 per cent moisture above was used rather than the figure for March 1 and 2 only because of the fact that it is impossible to make determinations rapidly enough to get many results in an eight hour run. There were no conditions which would vary the moisture in the steam from day to day; consequently, the average for all of these days is thought to be more nearly the average moisture for the days of the test than the results of these days only. For this reason, the average of a number of determinations was taken rather than those taken on just the days of March 1 and 2.

Fig. 6 shows the plot of a two days' continuous test taken on pressure readings with steam flow to heating system, which shows in a very interesting way the effect of a change from live to exhaust steam and vice versa, upon the pressure drop between the station and the end of the line. It is to be noted in this connection that the pressure drop decreased from 3.4 lbs. to a little under 3 lbs. at the time of changing over from exhaust to live steam; and again changed from 3.55 lbs. to 4 lbs. upon changing back again to exhaust steam operation.

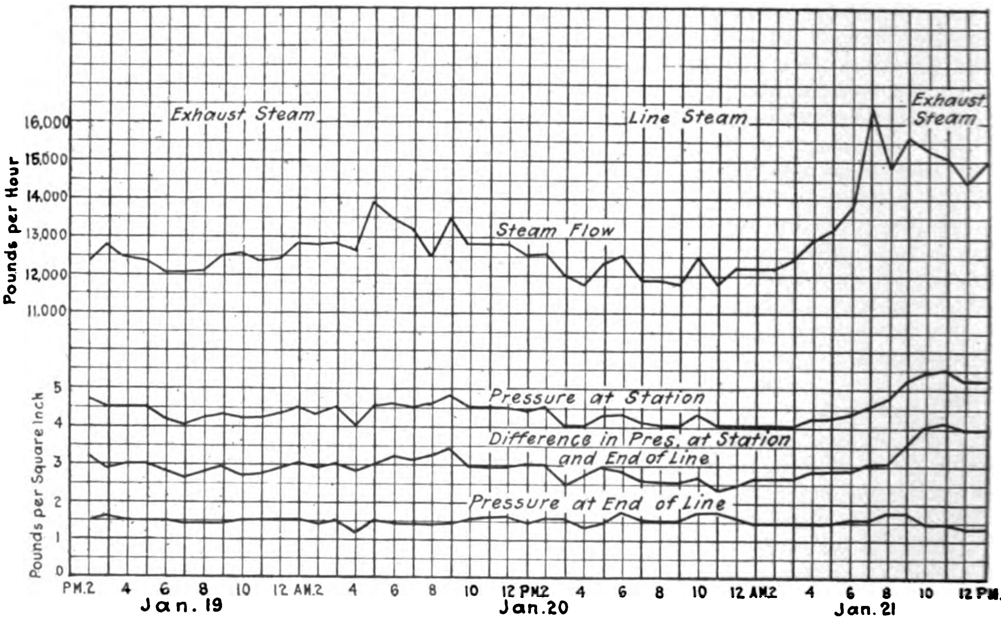


FIG. 6.—PLOT OF TWO DAYS' TEST, SHOWING EFFECT OF CHANGE FROM LIVE STEAM TO EXHAUST STEAM.

Occasionally station operators make the statement that the fuel burned or the heat required is increased in changing over from exhaust to live steam. While in certain cases this may be true, still, the tests shown below indicate that if care is taken to keep the pressure at the end of the line, or at least the average pressure throughout the system, the same, the send-out will not be increased. The fact

that it is increased is thought to be an indication that the live steam in the mains has raised the pressure in the mains, and consequently has increased the rate of condensation throughout the system; and from this observation it has been erroneously concluded that it requires more live steam to do a certain amount of heating than it does exhaust steam. The tests, as shown herewith, indicate, if a like amount of heating is accomplished that it requires no more live steam than exhaust steam to do it—in fact, the indications are just the reverse. The following is a digest of the principal results obtained:

COMPARISON OF EXHAUST AND LIVE STEAM.

The following percentages show the effect of changing from live to exhaust steam operation, calculated as a percentage of live steam conditions:

1. Per cent more steam to heating system 10.00
2. Per cent more heat to heating system 3.23
3. Per cent less heat per lb. of steam to H. S............ 6.23
4. Per cent more heat in coal fired 24.20
5. Per cent more heat in total steam generated 27.10
6. Per cent more main condensation 7.23
7. Per cent increase in pressure drop between station and end of line 30.90

These tests indicate that:

(a) The heat consumption for a heating system under similar weather conditions is practically the same for either live or exhaust steam operation.

(b) That the weight of steam sent to the heating system is increased as the heat content of the steam is diminished.

(c) That the carrying of an electric load in addition to the heating load can not be accomplished without an increase in fuel.

(d) The main condensation with live steam is less than with exhaust steam.

(e) The pressure drop between station and end of line is more with exhaust steam than with live, which is largely accounted for by the increased amount of send-out when using exhaust steam.

(f) Pulsations in pressure caused by the engine exhaust are not propagated very far from the source.

TEST DATA

General.		
Kind of steam	Exhaust	Live
Date	March 1, 1915	March 2, 1915
Time of day	8 a. m.—4 p. m.	8 a. m.—4 p. m.
Duration in hours	8 hours	8 hours
Weather	Clear	Clear
Ave. outside temperature, Deg. F	40.1	39.1
Ave. wind velocity, miles per hr	5.3 West	4.1 West
Ave. relative humidity, per cent	78	74
Pressures.		
Ave. boiler pressure, lbs. gauge	117	119
Ave. pressure in heating main at station, lbs. gauge	4.15	3.30
Ave. presure in heating main at end of line, lbs. gauge	1.40	1.20
Ave. drop in pressure from station to end of line, lbs.	2.75	2.10
Temperatures.		
Temperature make up water, Deg. F	58	48
Temperature feed water, Deg. F	190	192
Temperature in heating main at station, Deg. F	224	283
Coal.		
Kind of Coal	Tazewell Co. 1¼ Scrg.	Fulton Co. 1¼ Scrg.
Analysis of coal—		
Moisture	11.2	12.6
Volatile matter	27.3	23.7
Fixed carbon	39.9	36.8
Ash	21.6	26.9
B. T. U. per lb. dry coal	10,700	9,450
B. T. U. per lb. coal as fired	9,520	8,280
Total lbs. coal used	18,150	16,800

Steam and Water.		
Total lbs. feed water by Venturi meter	118,000	93,000
Total lbs. steam to H. S. by flow meter	80,400	73,040
Total lbs. steam to Calorimeter	220	60
Total lbs. condensation from separator	4,800	......
Total lbs. steam to heat feed water	14,950	11,780
Total per cent. steam unaccounted for	14.9	8.7
Ave. per cent. of moisture removed by separator	5.62	......
Ave. per cent. of moisture or superheat past separator	4.%	60° Sup.
Ave. per cent. of moisture or superheat before separator	9.37	60° Sup.
Ave. quality of steam leaving boiler	99%	99%
Efficiency.		
Average actual evaporation per lb. coal, as fired	6.5	5.54
Average equivalent evaporation per lb. coal, as fired	6.86	5.84
Average combined boiler and furnace efficiency, per cent.	70.0	68.4
Factor of evaporation	1.056	1.054
Combined elect. and mech. efficiency of engine and generator	80%	
Sendout Analysis.		
B. T. U. in total coal as fired	172,788,000	139,104,000
B. T. U. in total steam above feed temperature	120,891,000	95,120,000
Total B. T. U. sent to heat system above feed temperature	77,071,000	74,661,000
Total B. T. U. equiv. kw. h.	7,508,000	....
Total B. T. U. equiv. eng. and gen. loss	1,877,000	....
Total B T. U. to heat feed water	13,555,000	11,709,000
Total B. T. U. lost in condensation from separator	166,000	....
Total B. T. U. lost in Calorimeter	211,000	61,000
Total B. T. U. accounted for	100,388,000	86,431,000
Total B. T. U. unaccounted for	20,503,000	8,689,000
Per cent. B. T. U. unaccounted for	17.0%	9.1%

TABLE OF RESULTS OBTAINED WITH CONDENSING CALORIMETER

Central Illinois Light Co., Pekin, Ill.

Date	Duration (min.)	Temp. Outlet, Deg. F.	Temp. Inlet, Deg. F.	Temp. in Main, Deg. F.	Steam Press, lbs.	Wt. of Condensate, lbs.	Quality	Kind of Steam
3- 4-'15	28	140.8	59.6	226.0	3.8	18.63	96.00	Exhaust
3- 5-'15	17	107.0	59.6	224.0	3.7	10.81	97.00	Exhaust
3- 5-'15	30	142.0	59.0	224.6	3.9	18.63	98.90	Exh. & Live
3- 5-'15	19.5	114.8	58.0	225.3	3.9	12.63	99.75	Exhaust
3- 6-'15	23.5	125.2	59.5	224.0	3.6	15.00	96.50	Exhaust
3- 6-'15	10	97.0	58.0	224.0	3.9	6.70	93.20	Exhaust
3- 1-'15	28	117.0	41.0	225.0	3.8	17.14	96.40	Exhaust
3- 1-'15	21	101.0	40.0	227.0	4.3	13.64	97.30	Exhaust
2-18-'15	27	110.0	40.0	?	3.8	16.13	93.30	Exhaust
2-18-'15	28	115.2	40.8	?	3.8	16.63	97.20	Exhaust
2-19-'15	20	90.3	38.0	?	3.9	12.13	92.50	Exhaust
2-19-'15	28	112.0	39.0	?	3.9	17.13	91.50	Exhaust
3-10-'15	20	132.0	58.0	224.0	3.4	12.25	98.74	Exhaust
3-10-'15	16.5	102.7	60.0	224.0	3.1	10.00	95.40	Exhaust
3-10-'15	40	173.7	60.0	226.0	4.0	24.00	95.97	Exhaust
Average quality							96.00	

$$\text{Quality of steam} = \frac{WT}{wl} - \frac{H}{l}$$

Where W = weight of cooling water

T = diff. in temp. between entering and leaving cooling water

w = weight of condensate

l = Latent heat of steam at pressure on main

H = Heat of liquid (at steam pressure in main) above temp. of condensate

Exhaust Steam January 19 to January 20.

Time.	Station Pressure.	End of Line Pressure.	Flow Meter Reading.	Steam Flow.	Difference Bet. Station & End of Line.
1 p. m.— 2 p. m.	4.7	1.5	5.20	12,300	3.2
2 p. m.— 3 p. m.	4.5	1.6	5.25	12,800	2.9
3 p. m.— 4 p. m.	4.5	1.5	5.10	12,450	3.0
4 p. m.— 5 p. m.	4.5	1.5	5.05	12,350	3.0
5 p. m.— 6 p. m.	4.2	1.5	5.00	12,092	2.8
6 p. m.— 7 p. m.	4.0	1.4	5.00	12,023	2.6
7 p. m.— 8 p. m.	4.2	1.4	5.00	12,092	2.8
8 p. m.— 9 p. m.	4.3	1.4	5.15	12,491	2.9
9 p. m.—10 p. m.	4.2	1.5	5.20	12,576	2.7
10 p. m.—11 p. m.	4.2	1.5	5.10	12,334	2.7
11 p. m.—12 p. m.	4.3	1.5	5.10	12,370	2.8
12 p. m.— 1 a. m.	4.5	1.5	5.25	12,800	3.0
1 a. m.— 2 a. m.	4.3	1.4	5.25	12,734	2.9
2 a. m.— 3 a. m.	4.5	1.5	5.25	12,800	3.0
3 a. m.— 4 a. m.	4.0	1.2	5.25	12,624	2.8
4 a. m.— 5 a. m.	4.5	1.5	5.70	13,900	3.0
5 a. m.— 6 a. m.	4.6	1.4	5.50	13,455	3.2
6 a. m.— 7 a. m.	4.5	1.4	5.40	13,200	3.1
7 a. m.— 8 a. m.	4.6	1.4	5.10	12,476	3.2
8 a. m.— 9 a. m.	4.8	1.4	5.50	13,532	3.4
Live Steam January 20 to January 21.					
9 a. m.—10 a. m.	4.5	1.55	5.60	12,798	2.95
10 a. m.—11 a. m.	4.5	1.60	5.60	12,798	2.90
11 a. m.—12 a. m.	4.5	1.60	5.60	12,798	2.90
12 a. m.— 1 p. m.	4.4	1.42	5.50	12,534	2.98
1 p. m.— 2 p. m.	4.5	1.55	5.50	12,770	2.95
2 p. m.— 3 p. m.	4.0	1.55	5.30	11,940	2.45
3 p. m.— 4 p. m.	4.0	1.30	5.20	11,714	2.70
4 p. m.— 5 p. m.	4.3	1.40	5.40	12.271	2.90
5 p. m.— 6 p. m.	4.3	1.70	5.50	12,498	2.80
6 p. m.— 7 p. m.	4.1	1.55	5.25	11,861	2.55
7 p. m.— 8 p. m.	4.0	1.50	5.25	11,827	2.50
8 p. m.— 9 p. m.	4.0	1.50	5.20	11,714	2.50
9 p. m.—10 p. m.	4.3	1.70	5.50	12,498	2.60
10 p. m.—11 p. m.	4.0	1.70	5.20	11,714	2.30
11 p. m.—12 p. m.	4.0	1.60	5.40	12,165	2.40
12 p. m.— 1 a. m.	4.0	1.40	5.40	12,165	2.60
1 a. m.— 2 a. m.	4.0	1.40	5.40	12,165	2.60
2 a. m.— 3 a. m.	4.0	1.40	5.50	12,390	2.60
3 a. m.— 4 a. m.	4.2	1.40	5.70	12,915	2.80
4 a. m.— 5 a. m.	4.2	1.40	5.80	13,142	2.80
5 a. m.— 6 a. m.	4.3	1.50	6.1	13,861	2.8
6 a. m.— 7 a. m.	4.5	1.50	7.2	16,454	3.0
7 a. m.— 8 a. m.	4.7	1.70	6.4	14,740	3.0
8 a. m.— 9 a. m.	5.25	1.70	6.7	15,640	3.55
Exhaust Steam January 21 to January 22.					
9 a. m.—10 a. m.	5.4	1.4	6.1	15,263	4.0
10 a. m.—11 a. m.	5.5	1.4	6.0	15,055	4.1
11 a. m.—12 a. m.	5.2	1.3	5.8	14,432	3.9
12 a. m.— 1 p. m.	5.2	1.3	6.0	14,929	3.9

CONDENSATION IN MAINS.

	Exhaust Steam	Live Steam
Electric Station Drip Connection	0	0
Manhole No. 1......	0	100
Manhole No. 2......	2900	1700
Manhole No. 3......	1300	1300
Manhole No. 4......	1600	700
Manhole No. 5......	700	1300
Manhole No. 6......	100	100
Manhole No. 7......	600	800
Manhole No. 8......	400	500
Manhole No. 9......	1200	1700
Total	8800	8200
Lbs. per hr.	.1100	1025
Lbs. per sq. ft. pipe surface per hr....	0.063	0.059

Heat Emitting Capacity of Radiation.

By Charles D. Allan.

In The Heating and Ventilating Magazine for March, 1915, there appeared an article entitled "Heat From Radiators Under Different Temperatures," by Chas. A. Fuller, which contained information of unusual interest on this subject.

In this article Mr. Fuller shows clearly that the coefficient of heat transmission through heating surface varies with the temperature difference between the circulating medium and the surrounding air, as well as with the type of radiation.

Table No. 1 is a reproduction of a part of the data given in the article quoted, with some rearrangement to serve the purpose in hand, the column giving the values of W having been added.

TABLE NO. 1.

38 in. 2 col. cast-iron radiation.

T—T′	K	W=K(T—T′)
100	1.485	148.5
110	1.515	166.7
120	1.550	186.0
130	1.590	206.7
140	1.635	228.9
150	1.665	249.8
160	1.710	273.6
170	1.745	296.7
180	1.770	318.6

In this table

T = Temperature of circulating medium in degrees F.

T′ = Temperature of surrounding air assumed to be 70 degrees.

T—T′ = Temperature difference between circulating medium and surrounding air.

K = Coefficient of heat transmission expressed in B. T. U. per hour per square foot per degree of temperature difference between circulating medium and surrounding air.

W = Total B. T. U. transmitted per hour per square foot of heating surface = K (T—T′)

It occurred to the writer that there is probably some definite law governing the relation betwen T—T′ and W which might possibly be determined by plotting the relative values of each on logarithmic paper, and which in turn would enable a simple chart to be made by means of which the total heat transmission for all kinds of radiation and all values of T—T′, within practical working limits, could be directly read.

In the chart accompanying this article vertical distances are the logarithms of T—T′ and horizontal distances are the logarithms of W, both laid off to the same scale.

Nine points, clearly shown on the chart, are obtained by plotting the relation between T—T′ and W, as given in Table No. 1, for 38 in. 2 column radiation and these points come almost in a straight line that makes an angle of about 37¼ degrees with the horizontal.

Now the equation of a straight line, referred to rectangular co-ordinates, takes the form

(1) $y = mx + b$

in which m is the natural tangent of the angle with the horizontal and b is the intercept on the vertical axis.

As the natural tangent of 37¼ degrees is 0.76 we find by substitution that the logarithmic equation betwen T—T′ and W, as represented by a straight line passing through the points located, is

(2) $\log (T - T') = 0.76 \log. W + \log. C$

and the natural equation would be

(3) $T - T' = CW^{0.76}$

Normal conditions of operation may be designated as an average temperature of the circulating medium of 220° for steam systems, and 190° for water systems, the room temperature being 70° in each case, which would make T—T′ 150° in the former and 120° in the latter. The two heavy lines across the chart, respectively marked for each, represent these conditions.

Table No. 2, also compiled from the data in Mr. Fuller's article, gives the relative values of (T—T′), K and W for different kinds of radiation, with steam under normal conditions.

TABLE NO. 2.

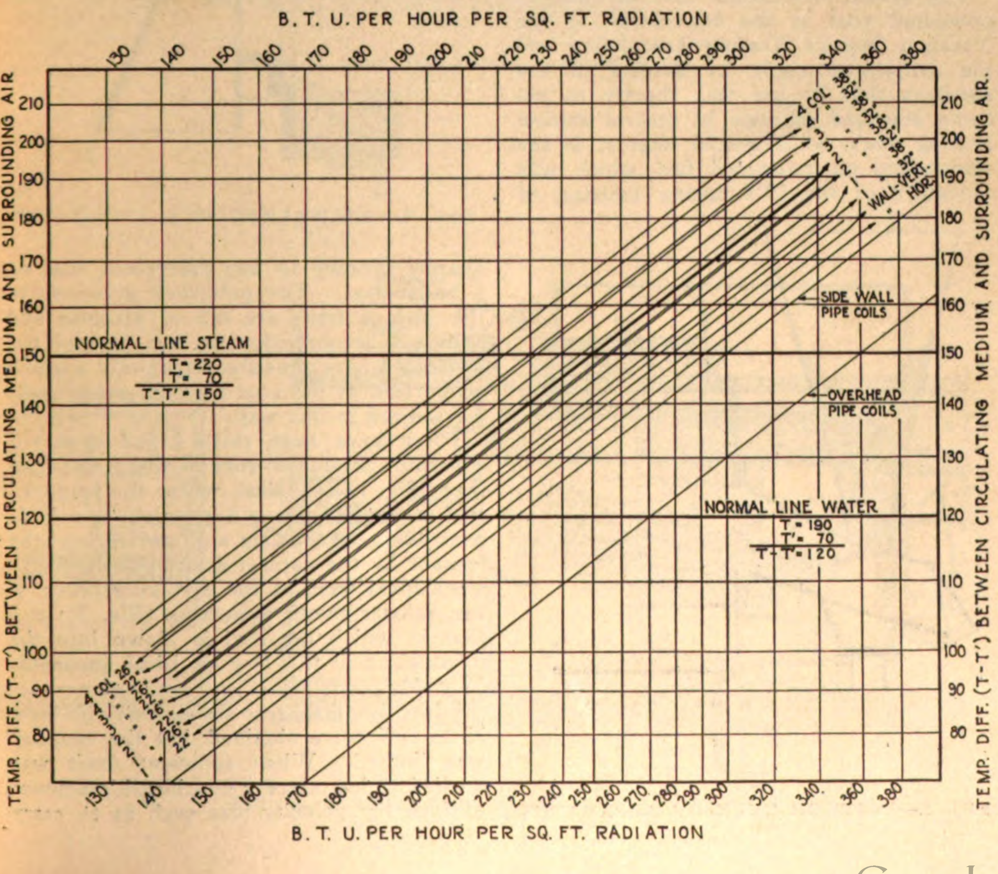
(T—T′) = 150° F. Throughout.

Radiation	K	W=K (T—T′)
4 col. — 38 in.	1.45	217.5
“ “ 32 “	1.50	225.0
“ “ 26 “	1.55	232.5
“ “ 22 “	1.60	240.0
3 “ 38 “	1.54	231.0
“ “ 32 “	1.60	240.0
4 col. — 26 in.	1.65	247.5
“ “ 22 “	1.70	255.0
2 “ 38 “	1.67	250.5
“ “ 32 “	1.71	256.5
“ “ 26 “	1.75	262.5
“ “ 22 “	1.80	270.0
1 “ 38 “	1.80	270.0
“ “ 32 “	1.83	274.5
“ “ 26 “	1.86	279.0
“ “ 22 “	1.90	285.0
Wall, Vertical	1.90	285.0
Wall, Horizontal	1.95	292.5
Pipe Coils, Side	2.00	300.0
Pipe Coils, O. H.	2.40	360.0

If the same law holds good for different types of heating surface, then the values of W given in Table No. 2 can be laid off along the "Normal Line for Steam" and lines drawn through these points, parallel to the line for 38-in. 2-column radiation, will determine the equations between W and T—T′ for each kind of surface.

Equation (3) then shows a very sim-

CHART SHOWING HEAT EMITTING CAPACITY OF RADIATION



ple relationship between these quantities, being the same in form throughout except that C is constant for only one type of surface, which is self evident, as parallel lines of the same slope will each have a different intercept on the vertical axis.

The chart as constructed will be found sufficiently accurate for all practical purposes.

Window radiation has been omitted by reason of incomplete data as to the values of K for different heights, and a line for overhead pipe coils has been added, on the basis of 360 B. T. U. per hour with steam under normal conditions.

With this latter type of heating surface none of the individual pipes are enveloped in the heat of those below, as in side wall coils, and some engineers claim for them a heat delivery as high as 400 B. T. U. per hour per square foot.

Pulverized Coal for Steam Making.

The recent discussion of the use of powdered coal at the convention of the National District Heating Association and the prophecies made by several of the speakers that its use was shortly to become standard practice in central station heating work, lends special interest to the symposium on powdered fuel which was a feature of the 1914 spring meeting of the American Society of Mechanical Engineers.

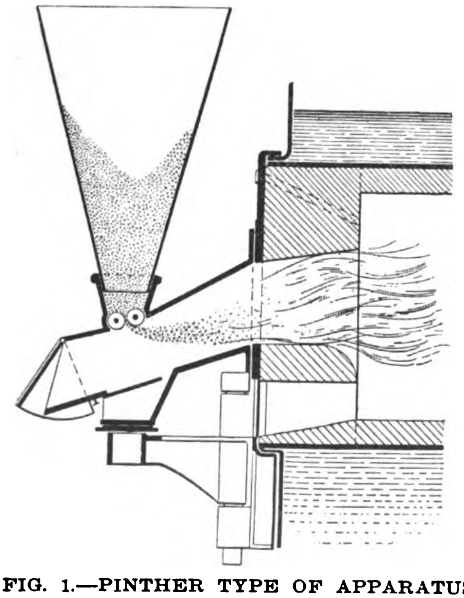


FIG. 1.—PINTHER TYPE OF APPARATUS.

The papers presented at that meeting included the following: "Pulverized Coal Burning in the Cement Industry," by R. C. Carpenter, Ithaca, N. Y.; "Pulverized Coal for Steam Making," by F. R. Low; and "An Installation for Powdered Coal Fuel in Industrial Furnaces," by William Dalton and W. S. Quigley. There was also a topical discussion upon the construction and operative features of pulverized fuel plants.

In Mr. Low's paper on "Pulverized Coal for Steam Making," he stated that numerous attempts have been made in the past quarter century to use pulverized coal as a boiler fuel. The published accounts of the various trials are full of promise and apparent accomplishment, but few of the processes have persisted, and only a small proportion of the coal used in steam making is fired in this way.

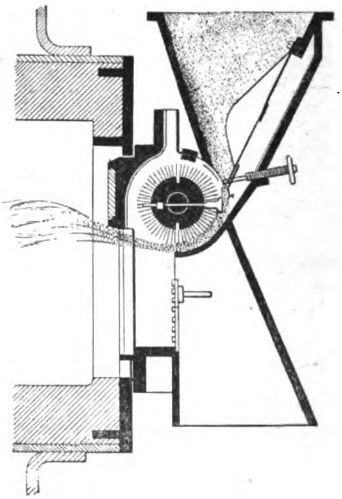


FIG. 2.—SCHWARTZKOPFF APPARATUS.

There have been three broad types of apparatus produced; that of which the Pinther (Fig. 1) is typical, where the prepared coal is emptied into a hopper above a feed-controlling mechanism and carried into the furnace by the natural draft; that having a mechanical feed, as the revolving brush of the Schwartzkopff apparatus (Fig. 2); and that in which the coal is blown into the furnace, as in the Day or Ideal apparatus (Fig. 3).

With the first type efficiencies of from 75 to 80% were obtained, but the capacity was limited. When sufficient draft was applied to introduce a considerable amount of fuel, the velocity was such as to carry

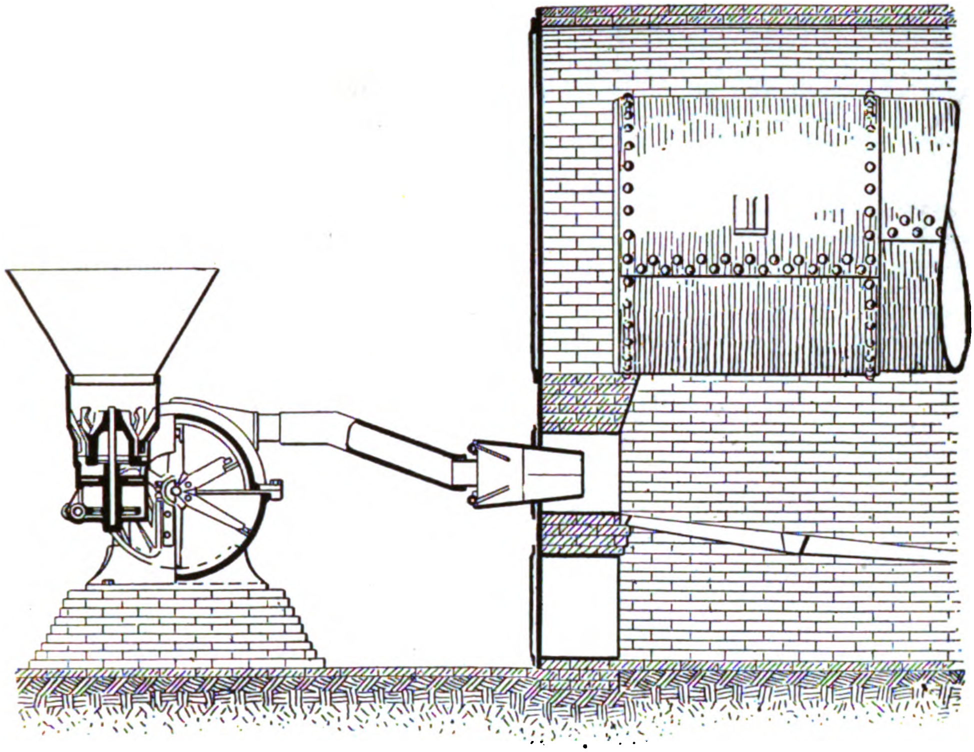


FIG. 3—DAY OR IDEAL APPARATUS.

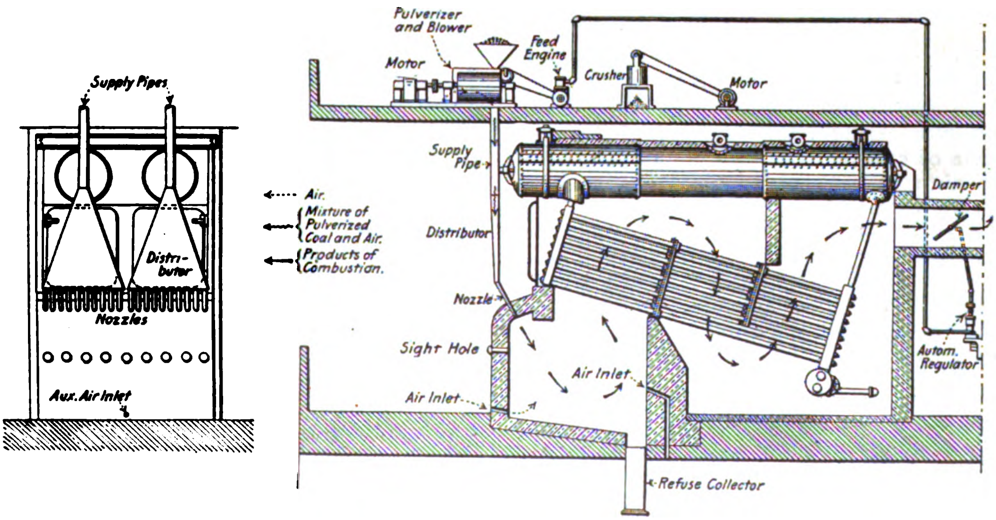


FIG. 4—BLAKE AND PHIPPS INSTALLATION.

unconsumed particles of coal into the back connection and tubes. When fuel is introduced into a powdered fuel furnace at a rate which will give the full rated capacity of the boiler, a particle will remain in the combustion zone of an ordinary furnace less than half a second.

When it is suggested that an air blast be used to introduce the fuel, the apprehension of an excess of air is natural. The relative volumes of equal weights of coal and air are about 1:990. It would hardly be expected to use less than 15 lb. of air per pound of coal, so that the relative volumes of coal and air introduced would be

$$1:(990\times 15)=1:14,850.$$

fuel mixed with air to the furnace, where, in this installation, it was introduced by a series of nozzles extending across the width of the furnace. A little less than the rated horsepower of the boiler was obtained with an efficiency of about 79%.

A later form of the Blake apparatus was installed in the winter of 1913 at the Peter Doelger brewery in New York City. The powdered coal was delivered into the top of an extension furnace or Dutch oven, as shown in Fig. 5. Smokeless combustion and high efficiency were obtained, the principal trouble being from slag, which accumulated on the roof and sides of the furnace, and piled up in such masses upon the floor that frequent shutdowns were required

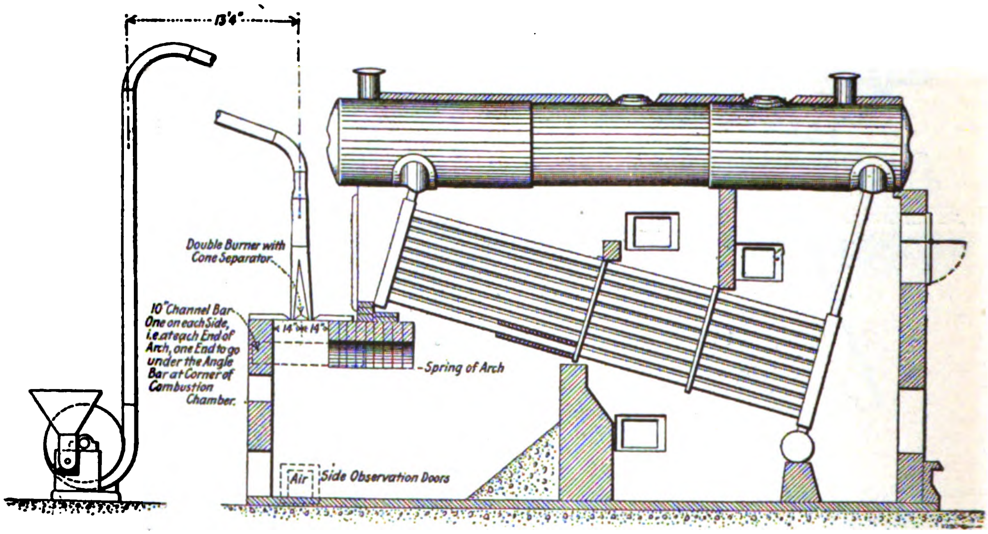


FIG. 5.—DOELGER INSTALLATION.

The diameter of the globe of air which would accompany each tiny particle of fuel into the furnace would be $14,850\ \sqrt[3]{14,850}$, or over 24 times the diameter of the particle of coal, so it will be seen that plenty of air may be used for fuel injection purposes without exceeding the supply required for complete combustion. In all of the systems at present in use, the fuel is introduced in this way, the blower usually being so combined with the pulverizer that the pulverized coal is blown into the furnace as fast as it reaches the necessary degree of fineness.

In 1910, J. E. Blake, of the Blake Pulverizer Co., installed, under a 300-H.P. water-tube boiler, at the Henry Phipps power plant in Pittsburgh, the arrangement shown in Fig. 4. The pulverizer served as its own blower, sending the pulverized

for its removal. They evaporated as much water with 1,000 lbs. of the pulverized as with 1,400 lbs. of the natural coal, but the cost of furnace maintenance, the frequent laying off of the boiler for the removal of slag and the cost of pulverizing counteracted, in the opinion of the operators, these advantages and the system was abandoned after a trial of about eight weeks.

With the ordinary method of burning coal, the grate with its bed of solid incandescent fuel more or less encumbered with ash and clinker, offers a considerable, a varying, and an uneven resistance to the passage of air, rejects the incombustible residuum with some difficulty and allows some of the unburned fuel to sift to the ashpit or to be fused in with the clinker. If the fuel can be burned in suspension, many of these difficulties disappear and the

draft-producing apparatus is reduced to that which will remove the products of combustion and allow enough air to enter to burn the required amount of fuel. There still remains, however, the difficulty of getting rid of the incombustible. With 10% ash there will be 200 lbs. of refuse to be got rid of with each ton of coal burned. If this is kept in a pulverized form it is carried into the back connection, the tubes and stack, and scattered about the neighborhood. If it is fused it attaches itself to the surfaces of the furnace and welds itself into masses, occasioning damage to the brickwork in its removal and comparatively frequent layoffs for cleaning. In one instance the molten slag formed in sheets and ridges upon the sides and in stalactites upon the roof of the furnace, while the floor was covered with a plastic mass, which cooled when the door was opened for its removal, and could hardly be got out without material damage to the boiler.

The possibility of getting an adequate supply of oxygen to the finely comminuted carbon allows perfect and smokeless combustion with a minimum air supply, but with the rates of combustion demanded in present practice, the result is a high temperature with erosive and reducing characteristics which, however good they may be for metallurgical processes, are not favorable to the longevity of a boiler furnace. If this temperature is kept down by feeding less fuel, the capacity is limited, while if it is kept down by using an excess of air the economic advantage just cited is sacrificed.

There have been several disastrous explosions of the prepared fuel outside of the furnace; but these can be easily guarded against. Coal, however finely comminuted does not contain the elements necessary for its own combustion, and if ignited will burn only slowly if kept in a compact mass. It is only when it is diffused in a cloud that the oxygen of the atmosphere can get to it quickly enough to make the rate of combustion dangerous. The pulverized fuel can be safely conveyed en masse in suitable holders, in screw conveyors, or even in cars and barrows if care is taken that it shall not be blown or sifted about in a finely disseminated state. In those systems where the pipe back of the blower is filled with an explosive mixture of coal and air, the rate of flow must exceed that of the propagation of flame in such a mixture, and in shutting down the coal supply should be shut off first. The pulverized mass will run like water, so that the pitch of chutes, conveyors, etc., must be so set as to provide against the flowing of their contents.

While anthracite dust can be used it burns more slowly than coal having a higher percentage of volatiles, and must be very finely pulverized. For most systems practically all of the coal should go through a screen having 100 meshes to the inch, and for coals having a small percentage of volatile or where very rapid combustion is imperative the coal is ground to a fineness which will permit the greater part of it to pass through a 200-to-the-inch sieve. Low-grade coals and coals having a large percentage of ash can be burned in this way, but there is a limit to the proportion of slate and bone that one can afford to grind, and an increasing proportion of ash means increased trouble from dust and slag. The earlier practice of taking up the impingement of the flame on a checkerwork or a heap of brickbats is out of favor. It simplifies the process of keeping the burner lighted, but burns up too much firebrick and makes a locus for the building of a slag heap. With an ordinary firebrick furnace well heated up there is no trouble in maintaining the flame steady, and it will re-ignite after having been turned out for several minutes.

The cost of pulverizing and the large initial cost of the drying, pulverizing, conveying and feeding apparatus, together with the fact that coal of practically all grades can be burned with a tolerable degree of smokelessness in the cheaper apparatus in common use with a degree of efficiency which leaves little margin to cover the increased expenditure, have combined to restrict the use of pulverized coal for boiler purposes to special instances.

Convenient Method of Sizing Returns.

The returns of a heating system may be readily sized by means of the following method:

When the steam supply is over 5 in. in diameter, the return may be one size smaller than half the diameter of the steam main. When the supply is less than 5 in., the return may be one or not more than two sizes smaller. For instance, with a main 6 in. in diameter the return main would be one-half of 6 in., or 3 in. minus one size smaller, equals 2½ in.

Building Operations for June.

An average loss of 23% in building operations in the United States is reported for June, 1915, as compared with the corresponding month last year.

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FEW actions of the National Association of Master Steam and Hot Water Fitters have been more gratifying, from many points of view, than the rescinding, at its last convention, of that clause of its "trade resolutions" which reads as follows:

"Those manufacturers and wholesale dealers who are in accord with us in this belief we look upon as our friends; our interests are mutual, and we shall use our best efforts to advance such mutual interests.

"For the information of the craft and the benefit of our friends we may, upon satisfactory evidence of the facts, print their name in our Official Bulletin, under the heading of 'List of Accord.'"

As will be seen, this limits the association's objects, as far as its dealings with manufacturers are concerned, to the following:

"The members of this association believe in trade protection. By trade protection we mean that manufacturers of, and wholesale dealers in, materials which enter into the construction of heating and ventilating systems, steam power plants and other pipe work done by those engaged in this craft, shall sell such materials for use in such work to those only who are regularly established in our line of business, and shall leave the preparation of plans and specifications to the heating contractor, the architect and the engineer. We shall endeavor by every legal and legitimate means to further trade protection."

It is to be regretted that the efforts to improve on the association's motto. "Who Helps Me, I Help," were not more successful, for this also smacks of a period that is rapidly passing away in the activities of commercial associations. Perhaps the broadest point of view is best expressed in the words of the board of directors' report:

"We shall all, no doubt, agree that we can not stand still; we must either go backward or forward and rules and regulations and even committees which may have been thought suitable to and for our association at the time of its inception may now not be in keeping with our aims and possibilities and work as at present understood."

WHILE on the subject of association work, it is perhaps an opportune time to voice the feelings of many who are fearful lest the commercial spirit gain too strong a hold on strictly engineering bodies. It is very evident that the best thought in the country is rather for a wider gulf between commercial and engineering interests than for a closer connection, and the conservative association will be the one that offers the least opportunity in this direction.

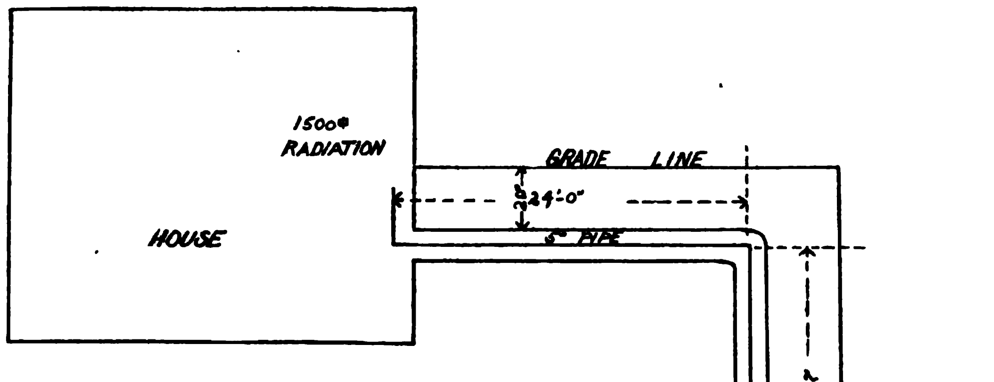
THE CONSULTING ENGINEER

The "Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

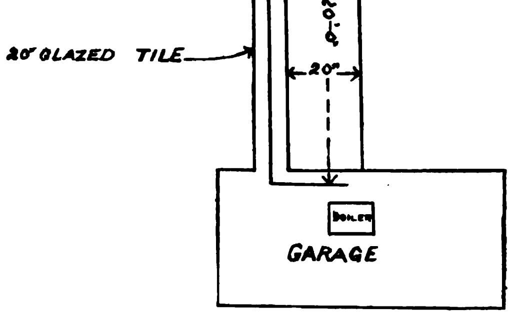
CONDUCTED BY IRA N. EVANS, C. E.

48—Heat Lost from Underground Steam Pipes.

QUESTION: Referring to the accompanying sketch, which shows a main run below the water line of a boiler and dripped to the sewer, this main is covered with three-ply asbestos air cell lining and is hung in the center of 20-in. tile. There is a free circulation of warm air from the boiler room to the basement of the house through the tile. Will you be kind enough to advise me as to the amount of water lost per twenty-four hours, based on the plant being in continuous operation? The plant is a vapor system, and 3 oz. is the pressure required in zero weather.



SKETCH OF UNDERGROUND STEAM MAIN FROM GARAGE TO RESIDENCE.



ANSWER: From the sketch there are about 50 lin. ft. of 5-in. pipe, or 1 sq. ft. of heating surface for each 0.62 lin. ft. of 5-in. pipe, or $50 \div 0.62 = 80$ sq. ft. of surface. Assuming a transmission of 1.8 B.T.U. per square foot per degree difference per hour, with an efficiency of 80% for the insulation, and surrounding air temperature of 45° F., we have, with a steam temperature of 215° F., the resulting condensation. The latent heat of steam will be 970 B.T.U. per pound.

$$\frac{80 \text{ sq. ft.} \times 1.8 \text{ B.T.U.} \times (215 - 45) \times 20\%}{970 \text{ B.T.U.}} =$$

5.05 lbs. per hour. 5.05×24 hours $= 121.2$ lbs. per 24 hours, or 1.94 cu. ft. per day. In case any of the above assumptions are not in accordance with the facts, they can be changed by the correspondent and the figures revised accordingly.

In the opinion of the author this would be bad practice, as the water lost from the boiler would entail filling at frequent intervals. If the water were wasted to the sewer, it would entail a reduction in boiler capacity due to the difference of temperature as taken from the city mains. It would be much better to lower the boiler sufficiently to provide a gravity return.

Where the water has to be supplied at such

frequent intervals it is apt to be forgotten and, with a fairly heavy fire and low water in a cast-iron boiler, when cold water strikes the hot iron, the result is a cracked section.

The free circulation of air over the covering does not improve the insulating qualities. The space should be enclosed so as to confine the air. One of the best insulators is composed of enclosed air spaces in the so-called air cell coverings.

By all means lower the boiler or provide a small motor-driven pump and receiver that will operate automatically, to return the condensation.

49—Advantage of Down-Feed Hot Water Heating.

QUESTION: Will you kindly advise me of the advantages of a down-feed hot water heating system for residential work? This system has been specified several times in house heating work in and around Boston, in houses of perhaps a little larger construction than the average. The writer cannot see what advantage this is over the regular style hot water installations.

At the same time will you advise me if it is necessary or good practice to run the feed pipes to indirect stacks in the basement (hot water) up one or two stories in a loop to get a head for circulation or will a direct connection be satisfactory? A direct connection seems to be customary with most contractors.

ANSWER: There is no advantage in using an overhead system in houses heated by hot water. The radiators are generally scattered in a building not over three stories high. A much cheaper method is to run a single pipe loop on the basement ceiling or one size throughout and shunt risers out to the radiators and back into the main. Where a building is over three or four stories the overhead system will be more advantageous and, for several stories, it will be much more economical, as single pipe risers may be used. When the mains are on the basement ceiling, double pipe risers have to be used, but the supply main in the attic is omitted.

Generally speaking, the determining factors in a system of piping will be the cost of installation; that is, labor and materials. The more a job is standardized and the different parts made repetitions in construction, the less the labor charge, and labor will count more heavily than material, as a rule.

Carrying the connection for an indirect stack up two stories is only of assistance at the start in clearing the radiator of cold water. After circulation is established, the two pipes will be nearly of the same temperature. The main points to observe in any hot water job is to prevent short circuiting and air pockets.

Legislation Affecting the Heating Industry.

That there is a growing tendency on the part of many of the State legislatures to pass drastic and ill-considered laws affecting the heating industry, was the theme of a notable address delivered at the recent convention of the National Association of Master Steam and Hot Water Fitters, by Charles K. Foster, vice-president and general manager of sales of the American Radiator Company. Mr. Foster spoke as chairman of the executive committee of the National Boiler and Radiator Manufacturers' Association and urged prompt and effective measures on the part of both associations to keep in closer touch with pending legislation and to see to it that only proper and desirable laws were placed on the statute books. Mr. Foster's address was reported in the association's Official Bulletin and is as follows:

"The legislatures of a few of the States meet every year, but the greater majority meet every other year in January of odd numbered years, that is, 1915-1917, etc. Beginning the first week in January, 1915, the legislatures of practically all of the States have had sessions.

"We have noted with considerable apprehension the growing movement toward various sorts of State legislation in connection with heating matters, and particularly as regards boilers, and this tendency has been very much more marked this present year than ever before. There has been a large mass of this sort of legislation introduced this past winter, but fortunately very little of it has passed, as most of the legislatures have been congested with bills. Up to date, (and almost all legislatures have adjourned), there have been about seventy-five bills introduced in a general way affecting the heating business coming in over thirty States, and much of this legislation has been wholly ill-advised and would have worked hardships to the heating industry had the bills passed. The legislation for the most part falls in the following classes:

"1. A very large number of the bills have to do in a general way with State inspection of steam boilers, most of the bills providing for State boards of inspection and requiring boilers to be inspected periodically and a fee to be paid. There is required as high as $10, per annum fee for each boiler, as well as reports, red tape, etc., of all sorts that goes therewith.

"Some of these bills are so drastic that if they become law it would mean a large decrease in steam and hot water heating jobs in favor of furnace work, especially in the smaller jobs. Most of these bills have some

exemptions, and wherever we have been consulted or have done any work in connection with pending bills of this sort, we have endeavored to have all house-heating boilers exempted, and all other boilers exempted carrying less than 15 lbs. pressure. I presume you are all familiar more or less with the so-called code which the American Society of Mechanical Engineers has gotten out as an aid in this direction, and they define a low-pressure heating boiler as one that carries 15 lbs. or less.

"2. The second type of bill comprises a large number introduced regulating the occupation of steam engineering. We are not prepared to say whether or not this is a desirable thing from the standpoint of the master steam fitters. Perhaps in some cases it is needed, and if the legislation is intelligently drafted it might work a betterment in the industry, but most of the bills that have come to us have not been intelligently drafted and were simply fee-getting and job-creating propositions. That is where more or less of this comes from, the endeavor to create political jobs. A bill may perhaps have a perfectly proper place as applied to high pressure work, but it will be so worded as to take in boilers of every description, and if a politician wanted to appoint a lot of people to earn some money, and perhaps help in his re-election, he would have an opportunity, and when such laws get on the statute books it takes a long time to get them off.

"3. Perhaps the most pernicious of all the classes of bills are those of the type of two or three which have been pending in the Illinois legislature, but which we understand were killed before the legislature adjourned. This class of bills for the most part provides that all operators of steam boilers over a certain size (and frequently the exemption is very small), must be examined by a State board and licensed by the State board to operate a boiler.

"We found several cases of this sort where this legislation was openly backed by the stationary engineer's organization. I do not know that we blame them for trying to widen their field, but it would certainly go hard with the heating business if low pressure steam boilers must be operated by licensed engineers. What I state about the stationary engineers is simply a fact, and not in criticism, but they are like every one else, and while we grant them the right to enlarge the scope of their operations, it is equally important for us, it seems to me, and for every master steam and hot water fitter, to be just as jealous of our prerogatives which relate to the erecting of heating apparatus; and if we get too many frills around it, there will not be as many installations made.

"4. A more limited class of legislation has been that in which power was given to some board, in some cases a State board, and in Pennsylvania, for instance, a local board in each city, to pass arbitrarily upon the safety of each installation and of all fittings and accessories of each installation before the job can be accepted and put in use. Here again an intelligent supervision might be a good thing for all concerned, whereas in a case like the Pennsylvania bill it is clearly apparent that both manufacturers and master fitters would be at the mercy of political job holders.

"Not only have this sort of laws been proposed in the State legislatures, but are cropping up now in some of the larger cities, for it will be recognized that where there is no State law on the subject a municipality can regulate these things the same as it provides smoke ordinances, etc. I hold in my hand a copy of an ordinance which was almost put through the city council of Kansas City a few days ago, and it well illustrates what I am discussing. This bill came right up to the last reading, and simply through lack of proper attention and ignorance of what was going on, on the part of the trade and on the part of the boiler manufacturers, it came close to passing. I have here a clipping from one of the Kansas City newspapers with the following headings:

"'Almost "put one over."' 'Joker in an ordinance would have knocked out steam heat; or those who used it in flats and apartments would have been compelled to employ licensed engineers.'

"I will read you what the article says:

"'An ordinance which would have required every flat or apartment house which uses steam heat to employ a licensed engineer or fireman to run its boilers, was killed by the lower house council committee yesterday afternoon after the Commercial Club, the Real Estate Exchange, the Board of Education, and about fifty property owners had entered an emphatic protest against it.

"'The ordinance furnished a striking example of the slipshod methods of legislation possible under the present two-house aldermanic system.'

"Then it goes on to say that somebody 'tipped off the "joker"' that was concealed in the ordinance.

"Then it continues:

"'A committee from the stationary engineers' and the firemen's union admitted frankly it had got the ordinance introduced, and members said they believed licensed

engineers should run even the low pressure boilers.'

"Now, gentlemen, that happened just the other day, and that bill was about to pass in Kansas City, if some parties had not interested themselves and defeated it.

BOILER INSURANCE.

"There is a phase of this whole subject which perhaps might as well be discussed frankly, although it has many angles. I speak of what appears to be an organized effort to popularize or by legislation make necessary or advisable the purchase of boiler insurance by the owners of low pressure steam and water boilers. We all know that such insurance can be had and we have no objection to it, but where it appears, as it did in the legislature of a certain western State, that two paid employes of a prominent boiler insurance company were members of the legisltaure and were members of the committee to which there was referred a bill which provided that every user of a boiler of a certain size, etc., must either have his boiler inspected periodically by the State or else have it insured by an authorized insurance company—that is going too far. I do not know that the insurance companies are to blame, I am not here to criticize them, I do not know but they have a perfect right, as have the stationary engineers, to use every legitimate method they can to increase their business; but, again, we ought to have and to exercise our right, it seems to me, as master steam and hot water fitters, and as boiler manufacturers, to see that the game is played perfectly fair, and perhaps both take a hand in it; because the technical complications in all these things will in the long run decrease your business and mine, and it seems to me that this association can be of the greatest aid to the trade at large in the following up and watching of these particular legislative matters as they come up.

"I want to add for the National Association of Boiler and Radiator Manufacturers, that your officers have done very prompt and efficient work whenever we have called on them, when these legislative matters have come up. Mr. Gompers has received many letters from us and we have received many from him, and each time that we have gotten together tremendous good has come out of it.

"We had a bill that I suppose very few people living in the State of Pennsylvania know was the worst of its kind that was ever tried to be passed. It prescribed a lot of commissions; there was a chief inspector in all these cities whose salary, I think, was to be $1,800 a year. The chief inspector had to pass on every installation and on all the goods that went into the installation. You could not change the position of a radiator in an office building or a home until you made a blue-print of it and sent it down to his office and it was O.K.'d by the inspector; then you could go on about your business. When we went to Harrisburg to discuss this legislation, we were told, You are rather up against it at the present time because the State of Pennsylvania needs, or thinks it needs, a lot of money, and any bill that creates a bit of revenue is a pretty hard thing to knock out at this particular time. However, the bill was defeated, so that the master steam and hot water fitters of the State of Pennsylvania can go on about their business from now on the same as they always have. That bill was printed; it came up for final reading and was about to go on the statute books. There was a proviso in the bill that all people engaged in the heating industry should stand an examination yearly. If you happened to be a contractor in Pittsburgh and took the examination there and you had a contract in Philadelphia, you had to be re-examined in Philadelphia.

"Now these are serious things, gentlemen, and most pertinent to your business. Desiring and believing, as boiler manufacturers, and as you do, in the best and closest and the right type of co-operation among the association of master steam and hot water fitters and that of the manufacturers, I make this plea that your association, in its own way and at its own time, should plan to even more closely affiliate with the manufacturers.

"I would suggest perhaps the appointment of some committee, if that is satisfactory, who will have this particular thing very near to its heart, with the idea of looking after it. And I believe that each local association throughout the country should be advised of these different matters so that they will be on the lookout for them. Now, in justice to the gentlemen who are in politics and the gentlemen who try to put these laws upon the books, a great many of them are actuated by the very best of motives. Unfortunately, they do not know your business and ours, and the phraseology of these bills is such that, while they mean one thing, they are open to almost any implication that any one might want to put upon them.

"None of us has any objection to our customers taking out insurance on low pressure boilers, but it does not appear to any of us, I think, either master fitters or manufacturers, that we want the public in general to think that a low pressure boiler is an explosive sort of thing and must be in-

sured the same as a high pressure boiler. Now, that is what I mean about those bills. They are meant for high pressure installations, a great many of them, but they are so worded that they apply to every boiler, and were they enforced the house heating business would be turned over to the furnace men.

"The manufacturers have done what they could to watch these matters and done what they could to substitute proper bills for poor ones. We will not have very much more of it, gentlemen, for two years, because nearly all the legislatures have adjourned, but in 1917 they will reconvene, and you can depend upon it that sooner or later almost every legislature in this country is going to have something to say about boilers and inspection and about insurance. There is a great wave of "safety first," and very properly so, and the only plea I make is that you will help yourselves and help us as manufacturers in getting the right laws so that our trade will be able to expand; so that it will not be put out of business, but that we may be able to continue along in our regular way and increase our business. We believe in the business, you believe in the business, and with the co-operation such as we have always had, and as I am sure we will have in the future, I am sure that we will get through with this all right."

As a result of Mr. Foster's address it was voted to be the sense of the convention that the association have a general legislative committee, composed of the legislative committees of all of the local associations, the chairmen of the various sub-committees to report regularly to national headquarters. The details regarding the size of the committee were left to the board of directors.

National Campaign on Overhead Charges.

One of the points brought up at the recent annual convention of the master steam fitters' association was the association's campaign in connection with "overhead charges," which, according to the report of the board of directors, has probably created more comment than any other one thing which the association has done.

"It is a farce," declared the report, "for us to go on formulating methods which are universally conceded to be good and legitimate and absolutely essential to our success in business if we do not have the slightest intention of adopting them."

The report stated that "canvasses have been made by several local associations to determine the average per centum of this item of overhead charges to gross business and it has been found that it runs from 12% to 17½% or even more; yet, in view of all this, with the full knowledge of the facts before them, many master fitters still persist in adding the paltry sum of 5% to cover this item and thereby make of themselves the unfairest kind of unfair competitors. It is high time that this sort of thing should be stopped and it is up to each and every member here to see to it that in his particular case it is stopped."

A Proposal to Award Contracts to the "Average" Bidder.

The practice of awarding heating contracts to the lowest bidder came in for a sharp scoring in the report of the board of directors of the master steam fitters' convention. After defining the meaning of competition as "the act of seeking or endeavoring to gain what another is endeavoring to gain at the same time" (Century Dictionary), the report adds:

"This definition, in itself, seems sufficiently clear to be easily comprehended by all of us. But what has become the meaning of the word as applied to our own business; what is it as we really understand it?

"To such extremes has the meaning of the word been distorted as to almost blot out its primary definition. Competition in feats of prowess or skill or art always has and always will mean only strength, agility, perfection, excellence and quality. Why should it not mean the same when applied to our work?

"Unfortunately, we have grown to associate this word with one consideration only—that of price; and the word today, with us, means—the endeavoring to gain what another wants by the exercise of cupidity, without regard to perfection, excellence or quality. Such competition is unfair and is based on the policy of 'each one for himself and devil take the hindmost.'

"Those conducting their business along these lines show an utter disregard for the rights of others. Competition in the form of mere price comparison is the most degrading form of competition to those who indulge in it. Said Mr. J. B. Adams, sales and advertising manager of Iver-Johnson Arms and Cycle Works, Fitchburg, Mass., recently, 'The only phase of competition which can benefit humanity is quality competition and that is the exact antithesis of price competition. The two cannot ride

in the same boat. When price competition begins, quality competition ceases.'

"We all know that to be a fact. Why should we not adopt it as the fundamental principle of our work?

"Where did the practice of awarding the contract to the lowest bidder begin? What excuse has such a practice for existing? We all know that it is impossible to secure the best or even good work by such a method. Why should we not take the initiative in an attempt to correct this method?

"Why should we not unite in an earnest endeavor to persuade architects and owners to abandon this practice and adopt a new one? Suppose they were to award the contract to the 'average' bidder, would not this retain all the essentials of competitive bidding, eliminate all temptation on the part of the bidders to 'skin the job' and secure for the purchaser the best possible results, in accordance with the true intent and meaning of the plans and specifications?"

The Motto of the Master Steam Fitters' Association.

The motto of the National Association of Master Steam and Hot Water Fitters, which appears on the association's Official Bulletin and stationery, is "Who Helps Me, I Help." In a report of a special committee on association motto, which was read at the association's recent convention, it was stated that for several years a convention committee has struggled with the question of changing the motto which, according to the report, "expresses somewhat after the order of Shylock that we want our pound of flesh—no more—no less."

After carefully considering a list of mottoes, texts and proverbs, the committee submitted two with the request that the convention adopt by a majority vote the motto it preferred.

The first motto submitted was: Industry, Integrity, Success.

The second motto was based on the following, taken from the convention program:

1. To foster trade and commerce among master steam, hot water and other pipe fitters.

2. To reform abuses and secure freedom from unlawful and unjust exactions.

3. To diffuse accurate and reliable information concerning the address and standing of manufacturers, contractors and merchants, and other matters by monthly or weekly bulletins, or otherwise.

4. To procure uniformity in materials and certainty in the custom and usages of this branch of business.

5. To promote a larger and more friendly intercourse among those engaged in this line of business, and for general mutual protection, conservation and advancement of the business of steam, hot water and other pipe fitting.

The leading words of the foregoing objects were taken to be "trade," "justice," "help" and "friends" which suggested the motto: "Friends Help in Just Trading."

At a later session the suggestions were taken up, but it was finally decided to retain the present motto of "Who Helps Me, I Help."

Progress of Standard Flange Schedule.

An interesting sidelight on the development of a standard schedule for flanges and flanged fittings is disclosed in the report of the Committee on Standardization of the National Association of Master Steam and Hot Water Fitters, as presented at its recent convention. The committee states that the standardization of material and measurements used in the steam fitting industry is not a difficult task and can easily be accomplished by a committee that is willing to devote a certain amount of time and energy for this purpose. But the great difficulty with standardization, which requires patience and perseverance, the committee continues, comes when the contractor tries to convince the manufacturer that he ought to change his patterns, sometimes at considerable expense, to meet the proposed standard.

However, the feature of the committee's report is the account of its efforts to come to an agreement with the American Society of Mechanical Engineers regarding the name of the schedule. On this point the report says:

"At our last convention we reported the final agreement by all societies, manufacturers and all concerned on the standards of flanges and flanged fittings, and so far as we are able to find out it has been accepted by all manufacturers and societies, and we believe this matter is now settled to the satisfaction of all.

"There was an effort made by some members of the American Society of Mechanical Engineers' committee to change the name from 'The 1915 U. S. Standard' to 'The American Standard,' but we have decided to stand by the action of the last conference of March 20, 1914, at which conference all matters were definitely settled.

"At our convention last year Edward B.

Denny and E. T. Child were appointed a committee to attend the spring meeting of the American Society of Mechanical Engineers at St. Paul, it being understood that there was to be a discussion on the name of the standard, and it was thought desirable that we should be represented in that discussion.

"At this meeting the privilege of the floor was granted to Mr. Denny, and he presented the case of the National Association of Master Steam and Hot Water Fitters in a clear and concise manner. His speech was printed in the August, 1914, issue of the 'Official Bulletin' and is familiar to the membership.

"No action was taken at this meeting, as your delegates were informed that the council of the American Society of Mechanical Engineers had decided to postpone the matter of a name for the standard until some later date. The name was to be settled at a joint conference between the parties at interest.

"This conference has never been called by the American Society of Mechanical Engineers, although they have proceeded to issue a pamphlet calling the standard 'The American Standard for Pipe Flanges, Fittings and Their Bolting.' In this pamphlet they fail to make any mention of the work which the National Association of Master Steam and Hot Water Fitters did in its preparation.

"Inasmuch as the pioneer work was done by this association, the manufacturers standing out for several years and the American Society of Mechanical Engineers joining us after several years, and owing to the fact that the name of the standard was definitely settled by vote at a joint meeting held on March 20, 1914, of the committees of the American Society of Mechanical Engineers, the manufacturers and this association (to whom the matter had been referred by all of the associations and departments of the United States Government, represented at the conference in Washington on March 7, 1914), when the name 'The 1915 U. S. Standard' was adopted, this association has decided to retain the name as adopted at that meeting.

"During the past year a chart, giving all the dimensions of 'The 1915 U. S. Standard,' has been prepared by our committee and 3,000 copies of the same printed by our association and one copy has been sent to each of our members. These charts are in great demand by engineers and manufacturers because it is the first real chart that has been printed since the adoption of the standard. This chart will be reproduced in pamphlet form."

RADIATOR VALVES.

Under the subject of radiator valves, the report states that the committee has made considerable progress on the standardization of these valves and adds:

"We have not attempted to tell the manufacturers how a radiator valve should be made, but to demonstrate to them the advantage to be gained by making some of the principal dimensions standard, so that valves of all makes will be interchangeable, such as the center to end of inlet and outlet, the size and shape of the opening through the hand wheel and possibly the size of the stem and the thread of the packing nut.

"We have all had our troubles with radiator valves. When we start to rough in a job, we must first of all make up our minds what make of radiator valve we are going to use, because of the different center to end dimensions, and even so simple a repair as a new wheel to replace a broken one often costs more than a new valve would cost.

"It is to overcome all these difficulties and annoyances that we propose to standardize certain dimensions of radiator valves and we believe that great benefit will be derived from standard dimensions by the manufacturer, the master steam fitter and his customer.

"A tentative standard has already been made and submitted to the manufacturers of radiator valves, and they have appointed a committee to consider it. From previous experience we feel sure that when we get the manufacturers aroused enough to appoint a committee to consider our standard it is a very good indication that something will be done. We are prepared to confer with them on any modifications which they may suggest. It makes no particular difference to us whether a 1-in. radiator valve is 3½ in. center to end or 4 in. center to end. What we want is to get them to agree to establish a standard that will be satisfactory to all. We hope to be able to present this matter for adoption at an early date."

The committee's report closes with an account of its efforts in connection with the development of standard boiler specifications which was taken up by the American Society of Mechanical Engineers, working in co-operation with a number of other engineering bodies, and which was brought to a successful conclusion early in the present year. The representatives of the committee at these hearings were Ernest T. Child and Robert S. Parks. The other members of the association's committee on standardization were William T. English,

chairman; T. B. Cryer, S. F. Gardner and Stewart A. Jellett.

Master Plumbers' Annual Convention.

An attendance of over 600 delegates was reported at the recent annual convention of the National Association of Master Plumbers, which was held in Chicago, July 13-15. It was the largest and one of the most successful in its history. The fact that the association has just passed through an unusually trying year through the indictment and trial of some of its members, who were charged with violating the Sherman law, gave a touch of earnestness that characterized all of the sessions.

In the report of President S. Louis Barnes, a detailed account was given of the various indictments and trials of the members, including the trial at Des Moines, Ia., of 36 members; the indictment at Erie, Pa., of 32 members, and the indictment at Salt Lake City of 14 members in that locality. The Des Moines case was discussed at length.

"Great stress," said Mr. Barnes, "was laid by the federal attorneys on the previous history of the National Association and numerous excerpts from our printed proceedings, from the organization of the national in 1883 up to the time of the trial, were read into the records, as were also many letters collected by the Government agents from different individual and local and State officers. Large numbers of witnesses were presented by the Government and every effort made by them to prove their contentions as to the illegal combinations they alleged existed."

After giving further details of the trial, President Barnes continued:

"Coupled with the weakness of the case made out by the Government it was assumed that the jury could do nothing else but bring in a verdict of acquittal, or at the very most, it was thought the worst that could happen the defendants would be a divided jury. Contrary to expectations, the verdict of guilty was rendered against all the defendants, despite the fact that against a number of the defendants not one word of evidence was presented.

"Judge Pollock, in his charge, stated to the jury: 'The acts done, and declarations made by others, are not admissible to prove the fact that any defendant participated in, or became a member of the conspiracy, if any is shown to have existed, that is to say, the membership of any defendants in the conspiracy charged, if shown at all, must be established beyond all reasonable doubt by some act, conduct, or declaration of such defendant and cannot be shown by act or declaration of another person.'

"To the minds of those attending the trial, hearing the evidence and the court's charge to jury, the verdict was most unreasonable and beyond belief.

"It would seem that the court felt as we do, the verdict was unfair, else why would he have reverted to the 'grudge against plumbers' in the minds of the 'farmer' jury and the difficulty of obtaining a fair trial for the defendants in a farming community? Without doubt, the Appellate Court, to which, as you have seen, the cases of four of the defendants have been sent, will consider the matter from a legal and unbiased viewpoint and that out of that court it is hoped may issue some settled opinion which will show us in what our rights and privileges as citizens of this country consists. Also, the ruling there obtained may be instrumental in bringing about a settlement of the Erie and Salt Lake City cases and then, if, as Judge Pollock stated, 'The purpose of the Government is not * * * to punish defendants * * * but to break up a practice it deems in contravention of the law,' these defendants certainly 'will desist without present punishment.'"

Immediately after the verdict was rendered a hearing on demurrer before Judge Pollock in Des Moines, on March 20, 1915, resulted in the sending of four of the Des Moines defendants to the Appellate Court as test cases. These will come before the Appellate Court in Denver, Colo., in September, 1915.

The total membership of the National Association of Master Plumbers was reported to be 9,883, a decrease of 541. This was considered to be a remarkably good showing in view of the association's difficulties during the year.

Reference was made to the bill introduced in the Senate last year to separate heating, ventilating, plumbing and electrical contracts from the general contracts in public buildings where the cost of such work exceeded $1,000. This bill, which is known as the Taggart bill, was not passed at the last session of the Senate and an effort will be made to secure favorable action at the next session.

The report of Secretary D. F. Durkin, Jr., showed that the per capita tax for the defense fund in the trial at Des Moines amounted to $36,957, which was $3,728 more than the cost of the trial, showing the splendid support extended by the individual members towards their fellow-members.

One of the resolutions passed was that the

incoming board of directors should appoint a committee to study the bonding question in view of the fact that a recent court decision showed that the bond of the general contractor does not protect the sub-contractor. It was voted to recommend to the incoming board of directors that the matter be taken up by a joint conference committee acting in conjunction with the steam fitters and architects.

A resolution that the National Association appoint a committee to confer with the manufacturers regarding the formulation of some plan of insurance to cover the cost of installing defective goods was voted down.

The new officers elected are: President, James S. Cassedy, Cambridge, Mass.; vice-president, David H. Roberts, Cleveland, O.; treasurer, William Coach, Philadelphia. President-elect Cassedy announced the appointment of Richard J. Welch, of Lowell, Mass., as secretary.

The manufacturers' display in the German and Elizabethan Rooms of the Congress Hotel embraced sixty exhibits and were, as usual, an important feature of the convention.

Summer Meeting of British Heating Engineers.

In order that there should be no break in its activities, the summer meeting of the Institute of Heating and Ventilating Engineers was held as usual, despite the fact that many of its members were at the front while others had joined the "Roll of Honor" made up of those who had given their lives to the cause.

The meeting was held at Leamington, June 22, the sessions being presided over by President H. H. Grundy. An attendance of forty members was registered. An animated discussion arose over the advisability of the removal of the names of alien members from the roll, as had been done in the case of other institutions. Finally, except in one instance, it was decided by vote that the names of non-British subjects be dropped from the list of members.

An interesting case of sub-contracting, which had been the cause of a legal dispute, was reported to the meeting by W. N. Haden. It seems that one of the members of the institute, a heating contractor, had made a bid for some heating work with a certain county council. The bid was accepted by the architect and incorporated in the estimate of the general contractor. The general contractors subsequently got into financial difficulties and the heating contractor looked to the county council for payment. The claim was disputed and the action resulted. The heating contractor won his case in the lower court, but lost it on appeal. It is now proposed to take the case to the House of Lords, as, according to Mr. Haden, it is a case of the greatest importance to the heating trade.

A. H. Barker gave a brief report of the continued research work at the University College and mentioned the fact that both of his assistants, Mr. Brendel and Mr. Avery, were with the army in France. Mention was also made of the death of Lieut. A. C. Taylor of Manchester, who a few days previously had been killed at the Dardanelles. An expression of sympathy and regret was displayed by the meeting, the members rising and remaining silent for a brief space.

Probably the most important action taken by the meeting was the passage of a resolution "that it is desirable immediate steps be taken to fix certain standards for the trade generally and the members of the Institution particularly, and that steps be taken to make it known to architects, consulting engineers, municipal engineers and others, that the Institution of Heating and Ventilating Engineers have approved and adopted the said standards for general use:

(a) Coefficients for heat losses from glass, walls, ceilings, floors, air changes, etc.

(b) Method of calculating the total surface in square feet of glass, walls, ceilings, floors, etc., bearing in mind that losses occur through all substances in every direction, and that heat must be provided to cover all such losses.

(c) Cubic contents of room and number of times the air has to be changed per hour.

(d) Formula for ascertaining the amount of radiation or pipe surface required to meet such losses, with, say, temperature of room 6°, temperature outside 30°, and temperature of water 160° F.

(e) Diagrams or comparative tables for any other temperatures, to facilitate the testing of plants under varying atmospheric or climatic conditions.

(f) Boiler rating for heating plants, and for hot-water supply plants.

(g) Proportions of boiler power to storage capacity.

(h) Data sheets or other formula for general use in the heating trade.

(i) Form of tender, with specification of the system, boiler power, mains, coating, radiator surface, testing—giving the equivalent inside temperatures as the external temperatures vary—terms of payment, maintenance, etc.

It was suggested that the members prepare short papers on the subjects of the various headings.

Announcement was made that the autumn meeting of the Institute will be held at the Holborn Restaurant, London, October 12, 1915.

CORRESPONDENCE

The Heating of the Rupert "Electric" High School.

EDITOR HEATING AND VENTILATING MAGAZINE:

In THE HEATING AND VENTILATING MAGAZINE for May, 1914, you published a description of an electrical heating system in a school at Rupert, Idaho. In the course of this article it was stated that 261 K. W. are sufficient to keep the entire building at 70° F. with the temperature outside at —15° F. In the following paragraph the writer states that the fan has a capacity for supplying 20,000 cu. ft. of air per minute.

I cannot understand how 261 K. W. are sufficient to give the results mentioned if the fans are actually supplying 20,000 cu. ft. of air per minute, this air being drawn from outside the building at a temperature of —15° F. The air supplied would be equivalent to 1,200,000 cu. ft. per hour, and as 1 K. W. has a heating value of 3412 B. T. U. per hour, 261 K. W. will have a value of 890,532 B. T. U. per hour. This gives us the equation: 55x890,532÷1,200,000=the temperature rise of the air supplied to the building.

The result is 40.8° which will only give the air a temperature of 25.8° F., if it is entering at —15.°, I cannot see how it is estimated that 400 K. W. is sufficient for the heating and ventilation of this building, as there will be an enormous heat loss over and above the heat necessary for ventilation. From your description one is led to believe that this is not a recirculation job, but the figures which are given may be based upon recirculation. I would greatly appreciate your enlightening me on the various points raised.

Seattle, Wash. F. J. McMORRAN.

ANSWER BY GEORGE L. DILWORTH.

"In explanation of the point raised by Mr. McMorran allow me to state that Rupert system permits of recirculation when such becomes necessary. The minimum temperature of -15° occurs but, perhaps, a half dozen times during the year and on such days it is necessary, first, to fill the building with fresh air and recirculate this until the rooms are at the proper temperature, all this before the opening of the building to the pupils, and then arrange the dampers to use partly recirculated air and partly outdoor air. The maximum used the past winter was 236 K. W.

"A new high school building, larger than the Rupert building, is being built this summer in the neighboring town of Burley, Idaho. It is being equipped entirely with electric heat and will get its current from the same source as does the Rupert building—the Minidoka Government dam. The superintendent of schools there the architect and the electrical contractors all made a very thorough investigation of the workings and success of the Rupert plant before adopting the system for the Burley school."

Efficiency of House Heating Boilers.

EDITOR HEATING AND VENTILATING MAGAZINE:

I should like to have you explain the following paragraph which appeared in the "Consulting Engineer" Department for June: "Some catalogues give the evaporation per pound of fuel, based on 80% of the coal burned and in one notable case a four-section, a five-section and a six-section boiler, all of the same type, are credited with 8 lbs., 8.5 lbs., and 9 lbs. of water evaporated per pound of fuel. This means that the last mentioned boiler is 12.5% more economical than the first boiler, and therefore, overrated in the first case."

I can see why the last boiler is 12.5% more economical than the first, but the final sentence seems confusing. Just why is the 9 lb. evaporation boiler overrated in the first place? I feel sure that there is some interesting reason for this statement and I should like to get clear on it. A. J.

ANSWER BY "CONSULTING ENGINEER."

The writer will have to admit that the statement about the first boiler being overrated was somewhat of an assumption, as the square feet of surface in these boilers are never given. Most of these boilers are rated under conditions which will give the maximum amount of steam. The size of grate is given, but the heating surface between the flue and grate only in a few cases.

It is reasonable to suppose that if we have a large grate and no heating surface, we will obtain poor results. The grate is simply a reservoir for fuel and the economy is obtained by the amount of heating surface between the flue and grate, which means a larger boiler and lower temperature of the gases. If the manufacturers gave the amount of heating surface, as well as the evaporation per pound of fuel, we would be able to

pass judgment and make comparisons more readily.

By operating a boiler with a high intensity of fire more perfect combustion is obtained and a high rating secured with a small amount of heating surface. The flue gases are apt to be too high, however, tending towards uneconomical operation. Under these conditions, the more perfect combustion makes up for the loss in heat in the flue gases.

On the other hand, a very slow fire, with restricted air supply, will tend towards imperfect combustion and a greater amount of CO. This, of course, is uneconomical and will give a reduced evaporation per pound of fuel and a low flue temperature.

Inasmuch as these boilers are rated for all the traffic they will bear, the writer assumed that by reducing the rating on the first boiler or increasing the heating surface proportionately, the manufacturer would obtain a better evaporation per pound of fuel.

Relation of Windows and Ventilation in Factory Buildings.

A recognition of the importance of good air conditions in factories is shown in the recent statement of a prominent automobile manufacturer who said that manufacturers in that industry alone lose $7,270,000 annually through the illness of employees. A variety of causes may be adduced for this loss, he added, but the majority of these incidental ills could be prevented by good ventilation and plenty of light. In proof of his argument, the manufacturer submitted a report made by Dr. Katherine H. M. Blackford, a student of efficiency and the psychology of managing men.

"One factory which I was called upon to investigate was an old-fashioned building with small windows, most of them covered with the accumulated dust and dirt of years, and having only most crude and primitive methods of ventilation," reads the report. "I found in that factory, out of the possible 31,173 days' work, there was an actual loss through employees' illness of 3,512, or nearly 11¼%.

"In another factory doing the same kind of work in a modern building with excellent light and scientific ventilation I found that of the possible 85,765 days' work there was a loss through illness of 1,547 days' work, or only about 1.8%.

"The case of these two factories would not necessarily be conclusive, but in all my experience I have found the same general relationship between light and ventilation and the number and length of absences due to illness."

"Modern manufacturers have learned that the windows in their buildings are of immense importance in the making of their product," says another motor man.

"In the last eight years, walls of glass and steel have supplanted the old-fashioned brick walls in practically all of the modern factories.

"A typical example of the new 'window wall construction' is the plant of the Continental Motor Manufacturing Company on Jefferson Avenue East, Detroit.

PLANTS WITH GLASS WALLS.

"Seven buildings in the Continental group are all built with steel 'window walls,' 'fenestrated.' The factory building is almost entirely glass, supported by concrete and steel. The windows, six and seven panes high, extend from the sill, which is some 3 ft. above the floor line, to the top of the ceiling. Ventilators, horizontally pivoted and set four to a bay, give ample ventilation in the power house, 40 ft. high on all four sides, so that the visitor standing a few feet away from the building can see directly through its walls. The company uses this construction in the roof, as well as in the walls of its buildings.

"Monitor sash hung at the top and swinging out at the bottom operated in long runs by a mechanical device is used in the sawtooth construction which covers many of the assembling rooms.

"Tight when closed and projecting when open, this sash offers a means of ventilation that keeps the building comfortably cool, while at the same time it admits a flood of light throughout the entire plant.

"The sash for the Continental buildings cost upward of $23,000, yet this cost compares favorably with that of brick walls and narrow windows."

Report on Factory Exhaust Systems in Illinois.

Details of the Illinois blower law, and rulings and suggestions made under this statute, are contained in the combined twentieth and twenty-first annual reports of the Illinois chief state factory inspector. This law compels the use of blowers on metal polishing machinery for conserving the health of the workmen. One of the rulings of the department is in connection with the placing of the hoods. These are sometimes located in the rear of the wheels at a distance of from 18 to 24 in. from the point of work. This location is disapproved by the department which is ordering that the hoods be located at a point directly beneath that part of the wheel which comes

in contact with the work and as near to the point of work on the wheel as the character of the object being treated will permit. A further recommendation is made that an effective suction be placed in the rear of the wheel near the center so that floating dust from the wheel that escapes from the front suction may be carried away.

The law, of course, prescribes the minimum sizes of suction pipes for given duties as well as fan capacities and the manner of running the suction pipes. Copies of the reports may be obtained from Oscar F. Nelson, chief state factory inspector, 1543 Transportation Building, Chicago, Ill.

"Air Return Systems" as a Standard Designation.

A proposal to have a general descriptive title for heating systems now known by various names, such as "atmospheric," "modulation," "thermograde," "fractional," "vapor," and "vacuum," was made by James A. Donnelly, president of the Positive Differential System Co., at the recent convention of the National District Heating Association, in Chicago. The idea is that the prospective buyer is apt to be confused by the various names given to the same general type of system and that if some such title as "air return system" were used it would eliminate confusion as well as centering attention on this particular field. The point is made that it would then be easy to differentiate the various systems by adding the particular trade name, such as "atmospheric air return system" and "modulation air return system," etc.

The proposal is to include under the classification of "air return systems" all those that pass the air as well as the condensation down the return pipes. The name of "air return systems," it is thought, best distinguishes the new and modern types of systems, having no air valves on the radiators, from the older systems which discharge the air from each radiator through an air valve into the air of the room. It would also distinguish them from the air line systems which conduct the air down on air line to be either discharged in the cellar by pressure or drawn out by use of a partial vacuum.

Another point made by Mr. Donnelly is that it is rather difficult at present to refer properly to these systems because the elimination of the air valve on the radiator is a negative rather than a positive feature. Furthermore, most of the air return systems use a fractional or modulating valve on the inlet of the radiator, while on the outlet a wide variety of appliances is used, including thermostatic and float valves, which are intended to pass the air and water, but to hold back the steam; also devices which only partially retard such passage, such as water seals and check valves. Still other systems use only union elbows which have no function in the operation of the plant.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

AIR FLOW—

Measurement of Air Flow. Arthur K. Ohmes. Instruments. Ills. 4500 w. Jour. Am. Soc. of Heat & Vent. Engrs.—April, 1915. $1.00.

EXHAUST STEAM—

Commercial Value of Exhaust Steam. A. Langstaff Johnston, Jr. Third article of a series deals with economies to be effected in the use of exhaust steam. 2500 w. Engng. Mag.—June, 1915. 40c.

FACTORIES—

The Heating and Ventilation of Factories. Effects of impure air, problems, methods used. Ills. 3000 w. Travelers' Standard—April, 1915. Price on application.

PIPE SIZES—

The Determination of Pipe Sizes for Hot-water Heating Systems. F. E. Giesecke. General description of method developed by Prof. Rietschel. Ills. 1500 w. Jour. Am. Soc. of Heat. & Vent. Engrs.—April, 1915. Serial. 1st part. $1.00.

PULVERIZED FUEL—

Powdered Coal. W. L. Robinson. How to use it and benefits derived. 2500 w. Ry. Age Gaz.—May 21, 1915. 20c.

The Use of Pulverized Fuel for Locomotives. Outline of tests extending over a year. 2200 w. Ry. Age Gaz.—April 30, 1915. 20c.

RADIATION—

Apparatus for the Study of Heat Radiation. J. D. Hoffman. Apparatus developed by students at University of Nebraska. Ills. 1000 w. Jour. Am. Soc. of Heat. & Vent. Engrs.—April, 1915. $1.00.

VENTILATORS—

Tests of Exhaust Ventilators on Passenger Trains. George L. Fowler. Results of experimental work; effects of position of the car in the train. 4000 w. Ry. Age Gaz.—May 14, 1915. 20c.

Organization of Carrier Engineering Corporation.

An important change is announced in connection with the Carrier Air Conditioning Company through the formation of the Carrier Engineering Corporation, with offices at the same address, 39 Cortlandt Street, New York. The new company will take over all of the special air conditioning work of the Carrier Air Conditioning Company, including all applications of the latter company's machines to the various industries requiring humidifying, dehumidifying or humidity regulation. The sale of Carrier air washers has been given to the sales organization of the Buffalo Forge Company, to be handled in the future with its fan and heating apparatus. The Buffalo Forge Company will retain the name of the Carrier Air Conditioning Company. Willis H. Carrier is president and chief engineer of the new corporation; J. I. Lyle, treasurer and general manager, and E. T. Murphy, secretary.

In announcing the change the company emphasizes the fact that air conditioning is now divided into two general lines, one being air washing and humidifying in connection with the ventilation of public or semi-public buildings, such as schools, hotels, court houses, theaters, etc., the application being simply an adjunct of the ventilating equipment for which standard designed machines have been developed. For this class of work the selection of the proper

WILLIS H. CARRIER.

machine is comparatively easy and the sales force of the Buffalo Forge Company, it is stated, is excellently fitted for this service.

On the other hand, but few more complex problems are dealt with by engineers than the regulation of humidity and temperatures in various industrial processes, such as textile mills, chemical plants, celluloid, photographic paper and moving picture factories, etc.

The high position held by the Carrier Air Conditioning Company is generally credited to the excellence of its engineering staff, and it is announced that the entire staff will be taken over by the Carrier Engineering Corporation.

J. I. LYLE.

Willis H. Carrier, the president of the new corporation, has probably done more for the development of air conditioning than any other man. His contributions to the scientific knowledge of the subject have brought to him international recognition, while his success in the solving of new problems in fan engineering and air conditions, with his inventions of humidity regulating apparatus, have given him a place among the foremost engineers of the country. He has been prominent in the councils of The American Society of Mechanical Engineers and The American Society of Heating and Ventilating Engineers. His hand book, "Fan Engineering," is the most comprehensive work of its kind that has been published.

Those in a position to know give to J. I. Lyle the credit for a large measure of the commercial success of the Carrier Air Conditioning Company, for he standardized the Carrier designs for the various applications and to him was also due the company's broad and liberal policy both in dealing with its customers and in the spreading of reliable information regarding the subject of air conditioning.

Mr. Lyle's opinions on engineering sub-

jects are given much respect and consideration by those who know him. He has presented several papers before The American Society of Heating and Ventilating Engineers and The American Society of Refrigerating Engineers, being a member of both organizations, and by invitation before the International Congress of Refrigeration. Mr. Lyle will have charge of the commercial end of the new company.

E. T. Murphy, the secretary, has won a reputation as an efficient engineer who never seeks the limelight, but who possesses a wealth of knowledge on air conditioning and kindred subjects and knows how to apply it. He will supervise the Philadelphia office, in which city he is well known.

The Chicago office will be in charge of A. E. Stacey, Jr., who assisted Mr. Carrier in his earlier experiments. Mr. Stacey is thoroughly familiar with every phase of air conditioning and will be supported by the assistant manager, E. P. Heckel.

E. T. Lyle, who has made a specialty of textile mill humidification, will be retained in charge of the Boston office.

L. L. Lewis, as heretofore, will be the engineer in charge of design and estimating.

NEW DEVICES

New Type of Flow Recorder.

Little can be done to determine or improve the efficiency of operations or processes without first having accurate, quantative knowledge. The difficulty of procuring easy and convenient means to measure the rates of flow of fluids and gases has hindered to some extent the development of steam plant machinery, but this condition is now being rapidly remedied by the introduction of various types of flow meters. Because of their simplicity and the ease with which they may be standardized, weirs are preferred by many for measuring liquids, more especially the V-notch weir.

With any type of weir or orifice, the rate of flow is dependent upon the head. The rate of flow, however, at a given instant is not sufficient, but continuous or total results are needed. This has led to the development of various types of flow recorders.

Fig. 1 illustrates the principle and essential elements of a recent type of such recorders. The float moves vertically in response to change in head. Ordinarily a cam is used to translate the motion of the float to that of the recording pen. Besides taking account of the law of flow over the weir, the translating mechanism also provides the proper ratio between float movement and pen movement. This is done by making the total length of the cam much greater than the movement of the float, using a multiplying gearing between the float stem and the cam. In the flow recorder here shown, the cam is laid out as a spiral on a flat circular plate and the multiplying mechanism consists of a small drum mounted upon the spindle of the cam and having wrapped about it a thin metal cable which is attached to the float spindle, a counter-weight on another cable serving to keep the first cable taut. The spiral groove is cut into the surface of the disk

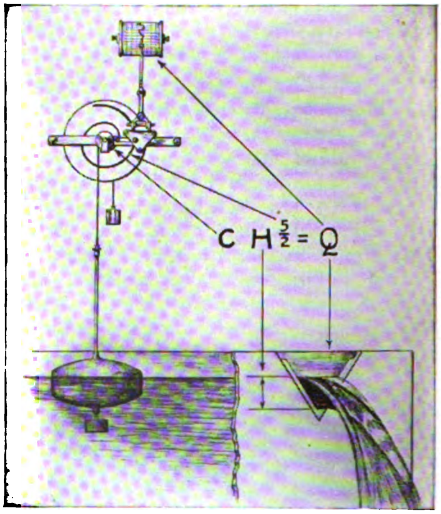


FIG. 1—DIAGRAM SHOWING PRINCIPLE OF COCHRANE RECORDER.

and is so arranged that the part of the cam corresponding to the low heads is near the center of the disk, and the part corresponding to high heads is near the periphery of the disk, whereby the angle between a tangent to the cam at any point and a tangent at the same point to a circle concentric with the disk is kept small, due to the fact that what would otherwise be the steeper part of the cam is at the greater radius. To accommodate the recorder for use with weirs of different heights it is only necessary to substitute cable drums of the proper respective diameters. One cam serves for all weirs, having the same law connecting head and flow, and hence it has been commercially feasible to devote considerable expense to the mechanical

means of reproducing this cam to insure accuracy.

The elimination of friction and backlash are prime requisites in the design of such apparatus. In the present case backlash has been eliminated by the use of a cable drum instead of the gear and pinion drive formerly employed, while friction has been reduced as much as possible by mounting the spindle of the cam upon anti-friction rollers.

The chart being driven uniformly by a clock, the pen not only records the rate of flow at each instant, but the area under the pen trace is proportional to the total flow for any elapsed period. In other words, the user of this recorder is supplied with a history of the rate of flow, as, for instance, the rate at which his boilers have been fed throughout the day, but may also obtain the total amount of water which has been fed to the boilers, and by comparing this quantity with the amount of coal used, may determine the total and average evaporation for the day. The Cochrane flow recorder is regularly supplied in connection with the Cochrane V-notch meters and metering heaters, manufactured by the Harrison Safety Boiler Works, 3189 North 17th Street, Philadelphia, Pa.

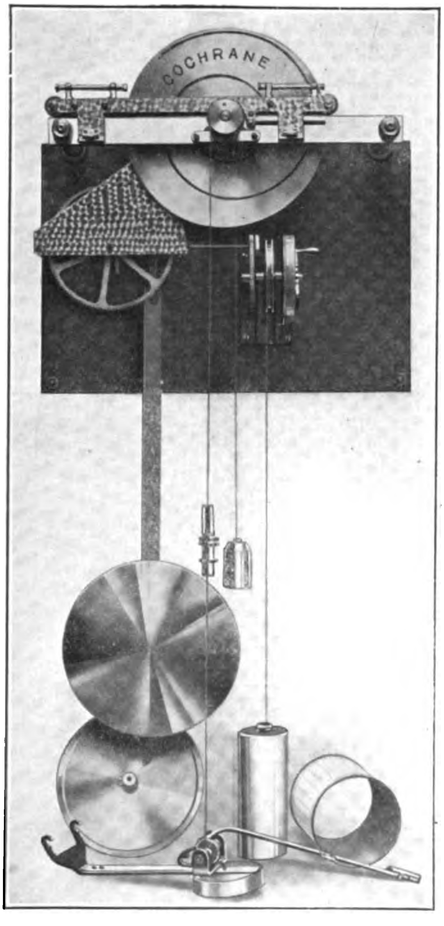


FIG. 2—COCHRANE RECORDER REMOVED FROM CASING, SHOWING ELEMENTS OF CLOCK MOVEMENT.

FIG. 3 — COCHRANE RECORDER READY FOR USE.

New Vertical Electric Condensation Return Pump.

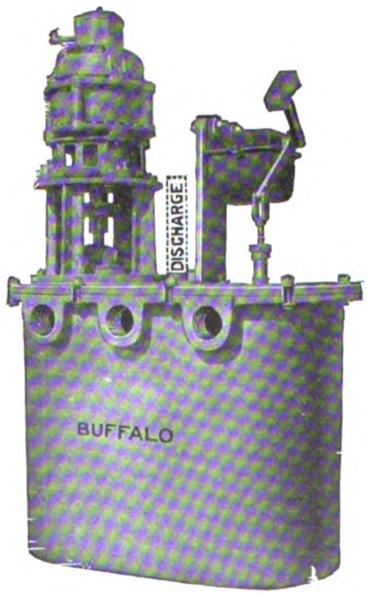
The difficulties of returning condensation on a heating system carrying very low steam pressures, with the usual steam pump and receiver outfit are well known. About three to five years ago various manufacturers of electric automatic centrifugal pumps placed these outfits on the market with the usual type of horizontal receiver elevated 6 to 10 in. above the pump. They were found to fill the requirements of low first cost, inexpensive operation and dependability, with practically no repair expense. A difficulty sometimes experienced with the original design of these outfits, however, was that the vertical height was such that to flow all condensation by gravity into the receiver, it was generally necessary to place the outfit in a pit, an undesirable location on account of dirt, heat and moisture, which affected the electrical equipment.

In the design shown herewith, which is that offered by the Buffalo Steam Pump Company, of Buffalo, N. Y., it is stated that this difficulty has been overcome and eliminated.

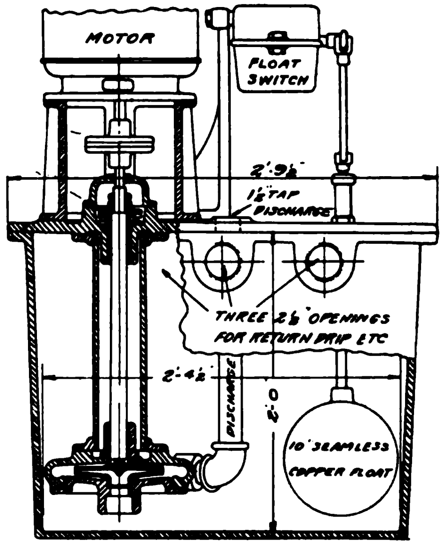
In the vertical condensation pump shown, the pump is of the vertical shaft type, submerged in a 40-gal. oblong receiving tank, which may be sunk in concrete and given no further thought, as the motor is elevated above the floor level, as is also the float switch. Here they may be given convenient attention, and having proper ventilation in this position will continue to give service without danger of being submerged by blow off from boilers, seepage or general drainage water filling the pit and drowning the electrical equipment.

All parts of the pump itself are carried on or suspended from the cover plate, which is conveniently removable, is of comparatively small weight and may be easily lifted off for cleaning or inspection of pump, pit, or float. The float is of spherical seamless copper, 10 in. in diameter, carrying a tobin bronze rod passing through the gland and stuffing box and actuating the float switch.

Leakage of steam cannot occur around the pump shaft, which is fully enclosed between pump casing and cover plate in a tight pipe casing. The weight of the moving parts is carried on a self-aligning ball bearing, the pump shaft being connected to the motor shaft through a flexible coupling.



BUFFALO VERTICAL ELECTRIC CONDENSATION RETURN PUMP.



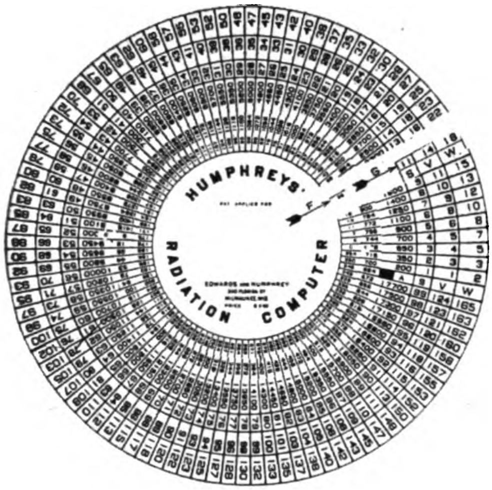
OVERALL DIMENSIONS 1-IN. AND 1½-IN. BUFFALO CONDENSATION RETURN PUMP.

The manufacturers state that the reports received from installations already made have led the company to prepare for a wide use of the outfit. The suggestion is made that inquiries should give amount of condensation to be handled, maximum steam pressure carried on the boilers, horizontal or vertical distances from pump to top of boiler and statement of electric current available for motor so that an outfit of proper capacity may be chosen.

A New Radiation Computing Disk.

An ingenious radiation computer, in the form of a circular computing disk, has been designed by Edwards and Humphrey, 300 Florida Street, Milwaukee, Wis. It is made up of three separate celluloid disks, one containing the exposed wall surface figures, the second the glass surface figures and the lower disk the cubic contents figures. The disks are so arranged that the movement of one disk on the other adds the radiation for wall, glass and cubic contents, so that the arrow will point to the final result, indicating the amount of radiation required for the room.

The computer is designed for the calculation of either steam, vapor or hot water radiation. The computations are based on a temperature of 70° F. in the room and zero outside. It is pointed out that when the outside temperature is —10° F., 15% should be added to the figures obtained by the computer. In other words, for every degree drop in outside temperature below zero an addition of 1½% is made to the radiation. For every degree increase



HUMPHREY'S RADIATION COMPUTER.

above zero a deduction of 1½% of the radiation is made. The radiation computer sells at $3.00.

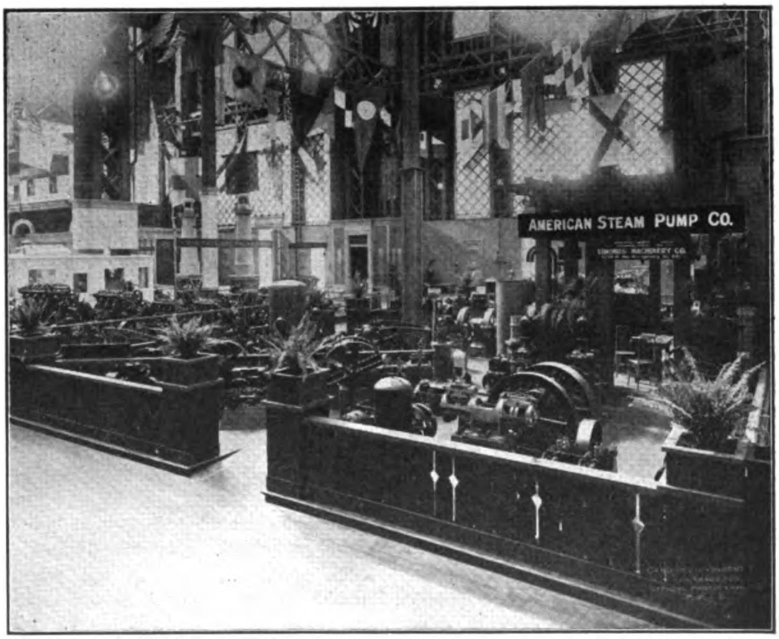


EXHIBIT OF AMERICAN STEAM PUMP COMPANY AT THE PANAMA - PACIFIC INTERNATIONAL EXPOSITION.

Panama-Pacific International Exposition Exhibits.

3—AMERICAN STEAM PUMP COMPANY.

Among the more important exhibits at the Panama-Pacific Exposition of interest to heating engineers is that of the American Steam Pump Co., of Battle Creek, Mich. It is located at Avenue E and Second Street in the Palace of Machinery and consists of a comprehensive showing of the different types of Marsh and American pumps and air compressors manufactured by this company.

Among other interesting features there is shown a sectional model of a Marsh Simplex boiler feed pump giving a view of the internal parts to demonstrate its simplicity. In this type of pump there are only two moving parts on the steam end and no outside valve motion. The manufacturers claim to have some 125,000 Marsh pumps in actual operation throughout the country. Next is a Marsh deep well engine with displacement plunger, with an all bronze artesian water cylinder. This type of equipment is used for raising water from very deep wells and forcing same into overhead tanks with one operation.

Added to the above is a showing of American steam pumps for various duties and several exhibits of American motor driven power pumps with capacities from 6 to 1,500 gals. per minute and air compressors. These compressors are designed according to the latest engineering practice and are claimed to be extremely efficient in operation. They are built with capacities ranging from 3 to 850 cu. ft. of free air per

minute, in both single and duplex types. Several of the pumps are shown in actual operation. The exhibit is in charge of the Simonds Machinery Company, 117-121 New Montgomery St., San Francisco, Cal., representing the manufacturers.

4—CRANE COMPANY.

Five railroad cars were used in transporting the material for this exhibit, which weighs in the neighborhood of 150 tons and occupies 4,000 sq. ft. of space in the center portion of Machinery Palace.

The main feature of interest is a 72 in. hydraulically operated gate valve weighing 57,000 lbs. and in operation throughout the exposition. A multiple steam trap working exhibit, consisting of tilt non-return traps for high pressure lines, tilt 3-valve lifting trap for low pressure lines and tilt direct return traps handling condensation in steam lines. The exhibit also contains one of each of the 17,000 articles made by the company.

The railings and arches are so arranged as to make it an educational and instructive exhibit and are composed of articles made by the company. Each side of the main entrance is made up of steam headers connected in multiple, using cast steel and wrought steel pipe with welded nozzles for the pillars. The tops of the pillars are capped with a 12-in. expansion "U" bend forming an archway. Beneath this bend and connected to the pillars is a 6 in. bend forming a loop on a complete circle. The railings on either side of the main entrance are made of a series of gate valves and "T's." One of the other entrances is made up of drainage fittings with the railings of angle and check valves and the other is constructed of pipe valves and fittings used in ice making and refrigerating plants handling ammonia.

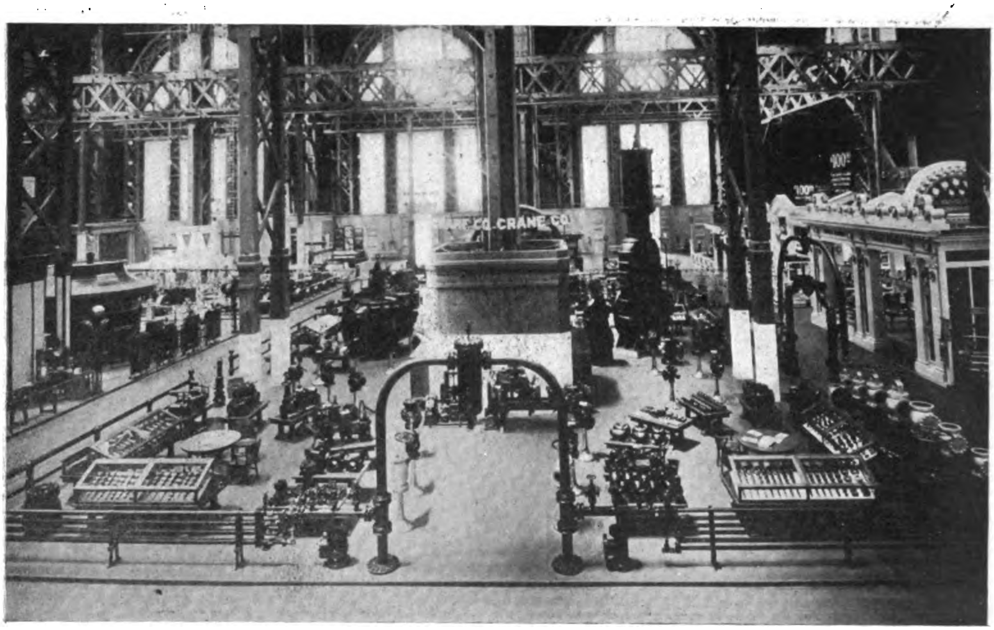


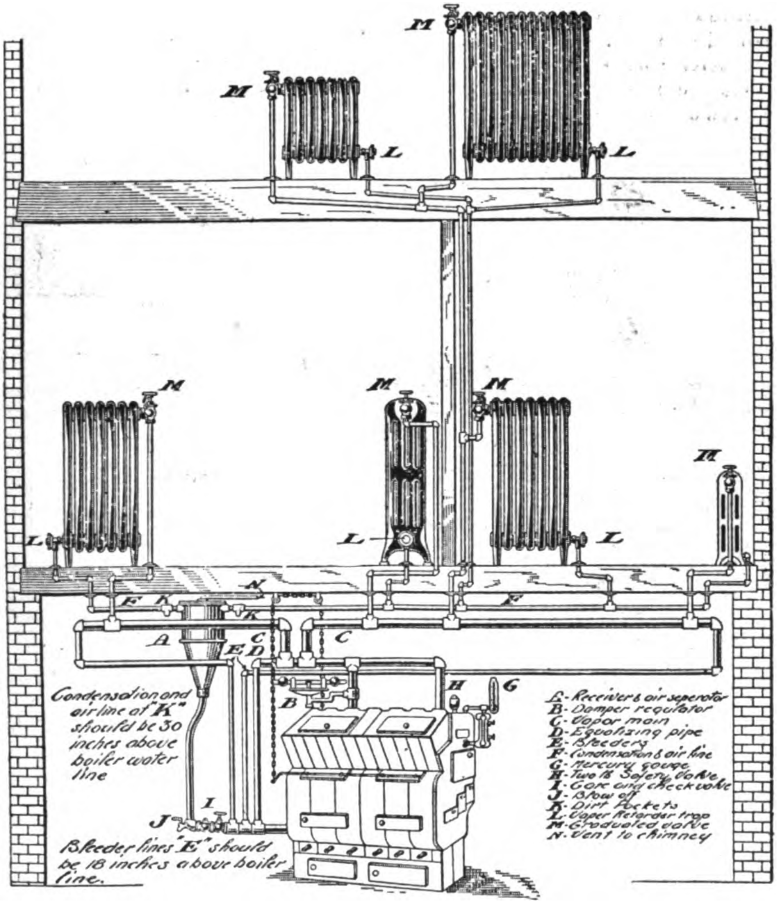
EXHIBIT OF CRANE COMPANY AT THE PANAMA - PACIFIC INTERNATIONAL EXPOSITION.

Trade Literature.

SUPERIOR MERITS OF SIROCCO is the title of a recent circular sent out by the American Blower Co., Detroit, Mich., in which reference is made to the patent infringement suit brought by the manufacturers of the Sirocco fan against the manufacturers of the Sturtevant Multivane fan. The decision in this case, which was favorable to the plaintiff in the United States District Court, was later reversed in the United States Circuit Court of Appeals which decided that the defendant's fan does not infringe the claims and further held that some of the claims of the Sirocco patents do not distinguish it from a prior unpublished foreign patent. The circular points out that no question was involved as to the novelty of the defendant's fan nor whether it involved any invention, the opinion of the court stating that it is enough different from

the Sirocco fan so that it does not infringe the Davidson re-issued patents Nos. 12,796 and 12,797. The reason given by the court is that the defendant's fan has a practical obstruction in its intake chamber, whereby it is distinguished from the "practically unobstructed intake chamber" of the Sirocco fan. Special attention is called in the circular to the advantage of having such unobstructed intake.

trolled by a new and sensitive damper regulator. Emphasis is laid on the fact that old systems, either steam or water, may easily be converted into Kelmac vapor heating systems. The return line after connecting to a receiver and air separator in the basement is vented to the atmosphere by way of the chimney. In one of the catalogues (No. 1) all the necessary information is given for installing the



ARRANGEMENT OF KELMAC VAPOR HEATING SYSTEM.

Kelmac Vapor Heating, described as "the system that heats," is the subject of three recent catalogues published by the Kellogg-Mackay Co., Chicago. The system operates without pumps or mechanical devices. It is a two-pipe system and includes the Kelmac vapor retarder which is designed to expel the air, return the condensation and keep the vapor from entering the return line. There is also the Kelmac graduated radiator valve to give control of the heat in each radiator. The operation of the boiler is automatically controlled by a new and sensitive damper regulator.

system, together with price lists, etc. Size of No. 1, 4½ x 7¾ in. Pp. 20.

Capacity the Same—Efficiency Greater is the title of a circular published by the Sarco Engineering Co., New York, in which a comparison is made of the sizes and prices of a bucket trap, with its floats, levels, water gauges, bowls, toggles and packing, with the Sarco valve. The point is made that the Sarco, rated size for size, has the same capacity as the tank trap, and costs one-third as much, while it occupies a fraction of the space. It

is also stated that the sales of Sarco valves to date amount to 350,000.

THE WALWORTH LOG, the monthly periodical published by the Walworth Mfg. Co., Boston, Mass., has some timely items on present trade conditions contributed by the president of the company, Howard Coonley, and by F. J. Chittenden, under "One Salesman's Views." An article on "Power Plant Piping," by Theodore W. Little contains some interesting hints on the lap joint or "Walmanco" joint.

GIFFORD AUTOMATIC VACUUM SYSTEM OF STEAM HEATING, of which over 3,500 successful installations have been made, is described in an interesting catalogue published by the Illinois Engineering Co., Chicago, Ill. The publishers state that the advantages secured by this system may be grouped into two general classes, either of which alone would justify its installation. These are the perfect circulation of steam and the positive operation of all the radiation throughout any heating or drying system, and the opportunity for fuel economy. The fuel economy is accomplished by the elimination of back pressure on engines, pumps, etc., supplying exhaust steam. Prominence is given to the statement that there are no patent infringement suits against this system or apparatus. The company states that its automatic float vacuum valve is the original open float water seal valve. The general arrangement of the system is shown in the accompanying diagram. At the bottom of the vacuum return main (18) is shown a by pass connection to the sewer, so that the plant can be operated as a gravity system temporarily if the vacuum pump or heater is being repaired and for blowing out the system when new. The principal devices used with this system are the float type automatic vacuum valve and the Thermo automatic vacuum valve. The catalogue also describes the Illinois Thermo modulating vapor system, which is a low pressure heating system with graduated steam control and using the same devices, together with the Illinois modulating or fractional radiator supply valve. A number of important buildings equipped with the Gifford system are shown. Size 6 x 9 in. (standard). Pp. 40.

Key to Diagram

1 Steam Engine
2 Feed Water Heater
3 Boiler Feed Pump
4 Vacuum Pump
5 Live Steam from Boilers
6 Cold Water Supply to Heater
7 Feed Water to Boilers
8 Exhaust Main
9 Back Pressure Valve
10 Gifford Cast Iron Exhaust Head
11 Gifford Cast Iron Oil Separator
12 Pressure Reducing Valve
13 Bypass around Reducing Valve
14 Exhaust Heating Main
15 Pipe Coil
16 Radiator
17 Automatic Vacuum Trap or Thermo
18 Vacuum Return Main
19 Vacuum Pump Strainer
20 Gauges and Board
21 Air Separating Tank
22 Air Vent to Roof
23 Water Seal Loop
24 Overflow from Heater
25 Gifford Steam Separator
26 Illinois Oil Trap
27 Waste Drip to Sewer
28 Automatic Vacuum Pump Governor

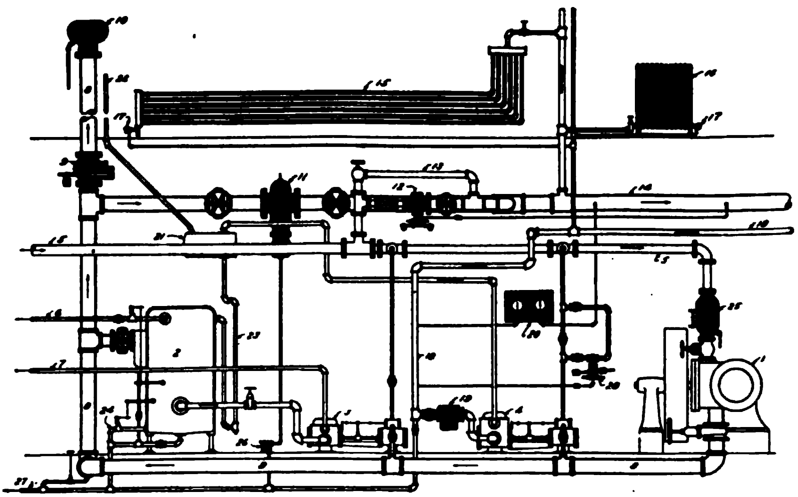
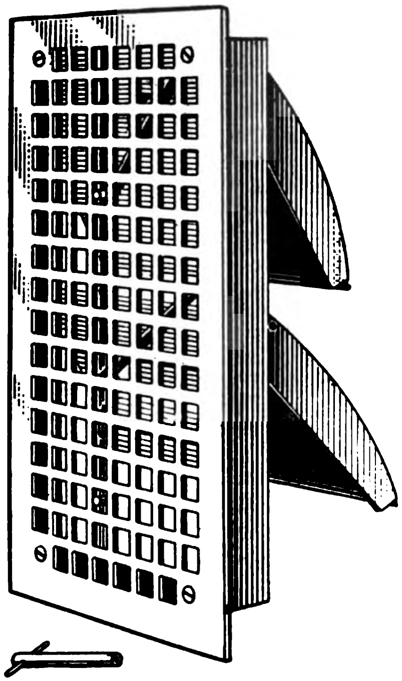


DIAGRAM OF GIFFORD AUTOMATIC VACUUM STEAM HEATING SYSTEM.

HANDBOOK OF INSTRUCTIONS FOR DESIGNING AND INSTALLING THE STERLING SCIENTIFIC HEATING SYSTEM is a notable booklet published by the Sill Stove Works, Rochester, N. Y., and reflecting the advances recently made in the development of warm air furnace heating. The book was compiled under the direction of the company's heating engineer, William F. Colbert, formerly engineer for the Federal Furnace League. As a result of tests of its furnace, the company guarantees its heaters when installed in accordance with its published rules and instructions to be capable of maintaining a temperature of 70° F. (or other specified temperature) in every room the system is designed to heat when it is zero outside. In connection with the heat loss factors, the handbook makes use of the "Sterling heat unit," which is described as equal to the number of B.T.U. of heat lost per hour through 2 sq. ft. of outside window surface on the windward side of a building when the in-

door temperature is 70° F. and the outside temperature zero. Under "first step," "second step," etc., full directions are given for designing and installing the "Sterling Scientific heating system," including items on estimating glass, wall, contents, exposures, temperatures other than 70° F., sizes, installation and covering of cellar heat pipes, partitioning heat pipes or wall stacks, trunk heat pipes, cold air supply to furnace, outside or fresh air supply, inside or return air supply, water heating coils, determining size of furnace, instructions for setting up furnace and notes on smoke pipe and chimney flue. The handbook concludes with a number of tables useful in designing the system. The publication is a notable contribution to the campaign for more scientific practice in warm air furnace heating and will be found of as much interest to heating and ventilating engineers generally as to strictly furnace men. Size 3¾ in. x 8 in. Pp. 36.

Aerco Key Operated Register, manufactured by Wm. Highton & Sons Co., Nashua, N. H., is featured in a newly-issued circular. This register is designed for use in connection with blower work. Through its use the flow of air may be regulated directly at the register face while the plant is in operation. The registers have been installed in buildings in which the heating and ventilating plants have been in operation for some time. A partial list of these installations is given in the circular.



AERCO KEY-OPERATED REGISTER.

At Your Service is a unique form of circular received from Frank A. Simonds, Grand Rapids, Mich., who has recently opened an office in the Shepard Building as manufacturers' agent for power and heating plant equipment and to act as consulting steam engineer. Among his specialties are una-flow engines, four-valve engines, single-valve engines, water-tube boilers, feed-water heaters, simplex and duplex steam pumps, rotary pumps, vacuum valves and heating specialties. His engineering services will include power plant plans, heating plant plans and power and heating plant improvement.

Centrifugal Blowers and Compressors for all pressures from 5 ins. of water, as in mechanical draft service, up to 125 lbs. per square inch, as for compressed air distribution in mines, machine shops, etc., are described in a 64-page book issued by the DeLaval Steam Turbine Co., Trenton, N. J. Numerous charts are given showing curves for the isothermal, adiabatic and actual compression of air, also the theoretical power required to compress air and characteristic curves of single and multistage blowers and compressors. Size 6x9 ins. (standard).

Lagonda Vibrator Cleaners are an interesting product described in the latest catalogue of the Lagonda Mfg. Co., Springfield, O. This bulletin discusses the formation and removal of scale from fire-tube boilers, with special reference to the use of the Lagonda vibrator cleaner. The cleaner is also designed to loosen the soot on the interior of the tubes, to be blown out by air or steam exhausting from the front end of the turbine which is a part of the cleaner. Size 6x9 ins. (standard). Pp. 12.

New Publications.

American Handbook for Electrical Engineers, a new handbook of which Harold Pender, Professor of Electrical Engineering, University of Pennsylvania, is the editor-in-chief, has been published by John Wiley & Sons, Inc., 432 Fourth Avenue, New York. The book is a compilation of 260 articles covering approximately 2,050 pages upon the various branches of electrical engineering and allied subjects. It has been prepared primarily for the practicing engineer, and all theoretical discussions are segregated into separate articles. The mathematical tables are notably complete and conveniently arranged. Size 4¼ x 7in. xviii—2,023 pages. Illustrated. Morocco, $5 net, postpaid.

The Unsteady Water Line in Heating Boilers.

An unsteady water line in a steam heating boiler may be due to several causes, as shown in the following sketches: In Figure 1 the water line is level with the upper return. Whenever the former drops below this level, there follows a rush of water, which fills the boiler due to the emptying of the long horizontal return. In an attempt to avoid this unsteady water line, a seal is installed as shown in dotted line, by means of which a so-called false water line is established.

In a certain installation typical of the foregoing, a seal 2 ft. 8 in. in height was used. Difficulties ensued, due to the return filling with water up to a point just below the wall radiators, and level with the top of the seal. As the vertical drop to the boiler constituted the long leg of a syphon, there was then an immediate rush of water to the boiler, due to the syphoning of the long horizontal return. Finally, a pet cock was installed at the top of the seal, and left open to break the syphon. The system has since worked satisfactorily.

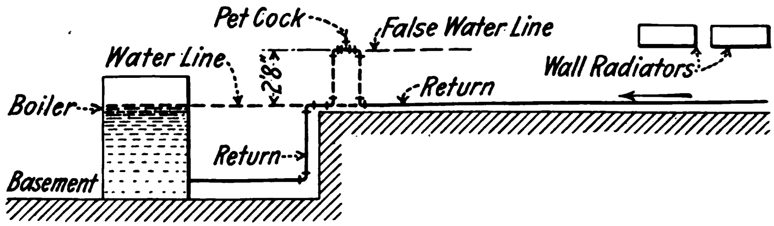


FIG. 1—LOCATION OF SEAL TO AVOID UNSTEADY WATER LINE IN BOILER.

In Fig. 2 the water column was installed at too high a point. This produced such a high water line that but slight steam space was left in the boiler. The small amount of steam usually present would condense whenever the fire doors were opened, and the resulting partial vacuum induced a rapid flow of the return water to the boiler and an unsatisfactory water line.

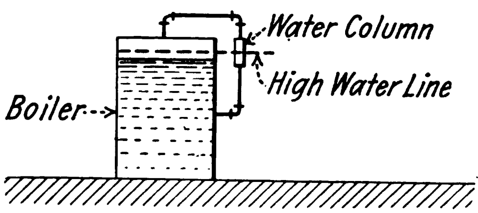


FIG. 2—UNSATISFACTORY WATER LINE CAUSED BY HIGH WATER COLUMN.

Measurements for the Household.

A new circular on "Measurements for the Household" has been sent to press by the Bureau of Standards, Washington. The circular aims to present a simple account of the more important kinds of measurements involved and their practical use in the work of the home maker. In the appendix is given a brief account of the bureau's activity in connection with the weights and measures of trade. The general subjects are commodities, heat, light, electricity and gas. Under heat the circular takes up the following:

What is meant by temperature and by heat; thermometers; convenient tests for thermometers; household thermometers, including room temperature thermometers, temperature out of doors, clinical or "fever" thermometers, reading clinical thermometers, bath thermometers, incubator thermometers, milk thermometers, maximum and minimum thermometers, candy-making thermometers, oven thermometers, refrigerator temperatures; refrigeration, including refrigerators, cooling by evaporation, frost; heating value of fuels; the saving of heat; comparison of heat insulators; radiation; heat in the household, including heating of rooms, amount of heat required to warm fresh air, amount of heat used in cooking and some other household operations, regulation of stoves, ranges, and other heating appliances, table of useful temperatures.

Copies of the circular may be obtained free upon application addressed to the Bureau of Standards. Request will be received at any time, although the printed copies of the circulars were to be ready for distribution in August.

Ohio Electric Light Association held its twenty-first annual convention at Cedar Point, O., July 20-23, 1915. Among the papers read was one on "Industrial Electric Heating," by H. O. Loebell, industrial heating engineer for the Henry L. Doherty Company.

Vacuum Cleaning Test in Hartford School Building.

Interesting results of a test of a vacuum cleaning system in the Wadsworth Street School, Hartford, Conn., are given in the accompanying curves. The building is a four-story and basement structure, the general arrangement of which is shown in the accompanying plan of the first floor. This plan also shows the vacuum cleaning piping layout. The approximate size of the school, including the kindergarten building,

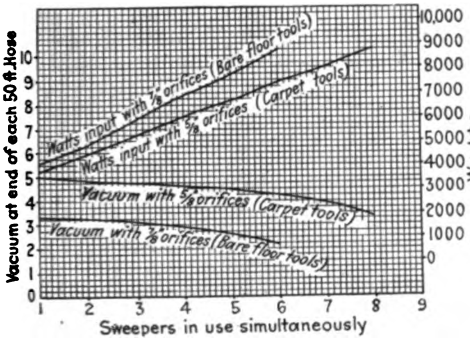


CHART SHOWING TEST OF VACUUM CLEANING SYSTEM IN WADSWORTH STREET SCHOOL.

at one end, is 345 ft. long by 115 ft. wide. It is equipped with a Spencer high-duty central cleaning system, including a four-sweeper machine of 10 H. P. capacity. The outlets are so placed that 50 ft. of hose reaches any point.

In the accompanying chart the lower line shows the vacuum maintained at the end of 50 ft. lengths of hose with from one to six ⅞-in. open orifices. The curve just above this shows the vacuum maintained at the end of 50 ft. lengths of hose with from one to eight ⅝-in. open orifices. The two upper curves show the watt-input under each of the conditions mentioned.

It is stated that among the actual results secured by this installation is a saving of $57.00 per month, representing a 33 1/3% return on the investment. This was accomplished through the reduction of the sweeping force from five to four men, while the building itself was kept cleaner than before. The installation was made by the Spencer Turbine Cleaner Co., Hartford, Conn.

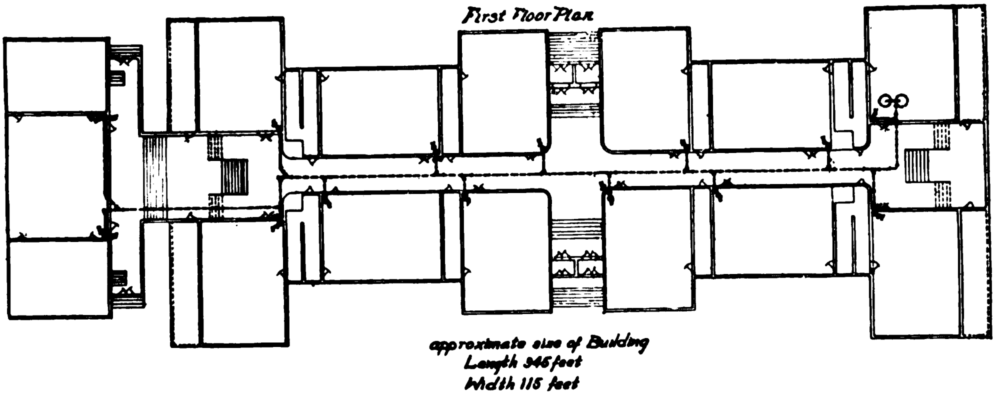
American Society of Mechanical Engineers.

The following names have been offered by the nominating committee as candidates for the offices indicated: For president, D. S. Jacobus, New York; for vice-presidents, William B. Jackson, Chicago; J. Sellers Bancroft, Philadelphia; and Julian Kennedy, Pittsburgh; for managers, John H. Barr, New York; John A. Stevens, Lowell, Mass.; and H. de B. Parsons, New York; for treasurer, William H. Wiley, New York.

At a meeting of the council, New Orleans was chosen as the place of the spring meeting in 1916.

New Quarters for the New York Office of the Lavigne Manufacturing Company.

The new quarters of the New York office of the Lavigne Manufacturing Company, Detroit, Mich., which have been taken in the Columbia Trust Company Building, 358 Fifth Avenue, New York, provide ample facilities for the handling of the company's increasing business in the sale of Lavigne products, including the Lavigne packless quick-opening radiator valves. The company's eastern sales manager is H. R. Watson.



VACUUM CLEANING SYSTEM IN WADSWORTH STREET SCHOOL, HARTFORD, CONN.

American Society of Heating and Ventilating Engineers

Summer Meeting to Be Held in Atlantic City Instead of San Francisco.

An important change is announced in the plans for the mid-summer meeting of the American Society of Heating and Ventilating Engineers. The society had arranged to meet in San Francisco, September 16-18, 1915. A recent canvass of the members, however, showed that many of those who favored the Exposition City as the summer meeting place would be unable to make the trip.

At a meeting of the council held August 12, the matter was discussed at length, the final decision being that it would be desirable to change the meeting place. Atlantic City was favored on account of its accessibility and also because no recent meeting of the society had been held there.

No change was made in the date, so that the society will meet in Atlantic City, Thursday and Friday, September 16 and 17. The professional programme will be the same as that prepared for San Francisco.

The Eastern members are interesting themselves in preparing a suitable entertainment programme and every assurance is given that the change in the meeting-place will not detract in any important respect from the value and pleasures of the meeting.

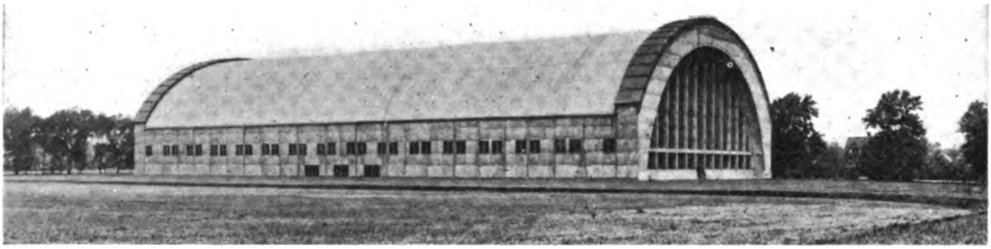
The programme will include the following papers and reports: "Determination of Pipe Sizes for Hot Water Heating Systems," by Prof. F. E. Giesecke, of the University of Texas; "Apparatus for the Study of Heat Radiation," by Prof. J. D. Hoffman; "Can We Locate the Neutral Zone in Heated Buildings?" by Secretary J. J. Blackmore; "Engineering Data for Designing Furnace Heating Systems," by Prof. A. C. Willard; together with a report adopted by the New York Chapter and referred to the society, of the "Profession's Efficiency and Welfare Committee."

ADVERTISERS' INDEX

*Every other month.

THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY | NEW YORK | SEPTEMBER, 1915



ARMORY BUILDING, UNIVERSITY OF ILLINOIS.

A Drill Room That Requires 23,000 Square Feet of Direct Radiation

PROBLEMS INVOLVED IN THE EQUIPMENT OF THE ARMORY BUILDING AT THE UNIVERSITY OF ILLINOIS.

BY GEORGE B. RICE.

At the time the problem of designing a heating system for the Drill Hall, at the University of Illinois, came up for consideration and definite decision, the room was one of the largest of its type in the country. Its principal dimensions are as follows:

Length	ft.	416
Width	ft.	212
Height to spring of segmental roof trusses	ft.	40
Height to top of roof trusses	ft.	95
Average height	ft.	81
Floor area	sq. ft.	88,000
Wall area, sides and ends	sq. ft.	46,200
Glass and door area, sides and ends	sq. ft.	21,200
Roor area	sq. ft.	105,000
Cubic contents	cu. ft.	7,101,325

The floor is of concrete except for an oval 340 ft. long and 140 ft. wide in the central portion, which is of sand and clay on a cinder foundation. This oval is of sufficient size for a seven-lap running track, its purpose being to permit the use of the building for general athletic sports.

The side walls are 8-in. hollow tile, plastered on the outside. These walls form a temporarv closure for the sides and in the completed building about 80% of them will be removed to provide passages and openings to rooms to be located in the two wings which will form part of the completed building.

The ends are all glass except for concrete pilasters, transoms and plastered arches. The area of glass for each end is 8,600 sq. ft. and of pilasters, etc., 8,000 sq. ft.

The main roof is of composition on 1-in. T & G sheathing. The roof for massive projecting cornices at each end is of copper on wood sheathing These

cornices and extension of same form open ways approximately 12 ft. square which are utilized as fan rooms, electric service rooms, toilets, stairways to the roof, and suction chambers for fans.

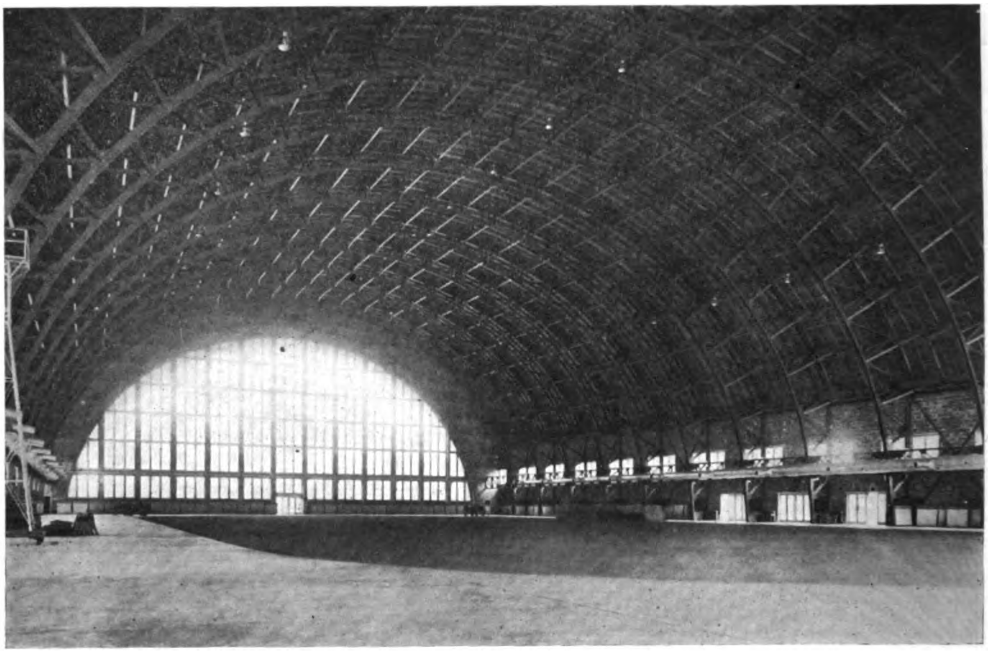
The main framing for this portion of the building consists of 16 three-pin arch trusses built up of Bethlehem sections.

HEATING SYSTEM.

In view of the conditions imposed, practically all suggestions that were received, either through invitation or otherwise for the design of the heating system, were rejected because, for the most part, they involved changes in the design of the completed building or marred the architectural characteristics of the main room.

Most of the suggestions received were for an all hot blast system, in combination with some direct radiation to take care of glass surfaces at the ends. These suggestions involved some 10,000 sq. ft. of heaters, in addition to the direct radiation, and fan capacity of about 150,000 c.f.m. to heat from 0° to 65° F. in one hour. A careful study of conditions should convince the advocates of this system that, while it is a splendid one, it cannot be installed in this building without incurring extraordinary expenditures for changes in the design of the steel work or for special fan houses, underground piping to same, underground ducts from the fans, and drainage for the ducts, or waterproofing for same.

As the accompanying figures indicate, the system installed has direct cast-iron water radiation as the main feature and two fans, each with 1168 lin. ft. of 1-in. pipe coil indirect. The purpose of the indirect is to take care of extreme weather conditions, or to be used in milder weather when the direct radiation for the sides of the building may be shut off, as well as to recirculate the air in the building.



GENERAL VIEW OF DRILL HALL, ARMORY BUILDING.

The steam flow mains enter the building from a manhole at the southeast corner, rise to a height of 14 ft. from the floor, divide into two 8-in. mains and extend around the ends and sides to the diagonally opposite corner, grading with the steam and reducing in size as the load is taken off. Anchors and double swing joints are placed approximately 100 ft. apart. For anchors the main is strapped to the steel work of the building, and

swing joints in straight runs are made up of two 45° and four 90° ells. The swing joints at three corners of the building are arranged to take the expansion of the two runs which are at right angles without disturbing the alignment of either run.

The return main is below grade, inside the building for the ends and outside for the sides, and is run in split tile.

The supplies to all groups of radiators are taken out of the bottom of the main and are dripped through thermostatic traps. These connections are at each truss, 26 ft. apart for the sides, and at each pilaster, 13 ft. apart for the ends. This reduces the accumulation of condensation in the mains and gives better quality of steam for the radiators.

The supplies are connected at the top of the radiators and returns at the bottom opposite the supplies. Returns are passed through a thermostatic trap for each radiator that is located on or near the floor and for each pair of radiators on columns or purlins above the flow main.

The connections from flow and return mains for the sides of the building are run in the channels of the steel trusses in order to conceal the work as much as possible. These connections at the ends of the building are kept near the pilasters in such a way that they are not objectionably conspicuous.

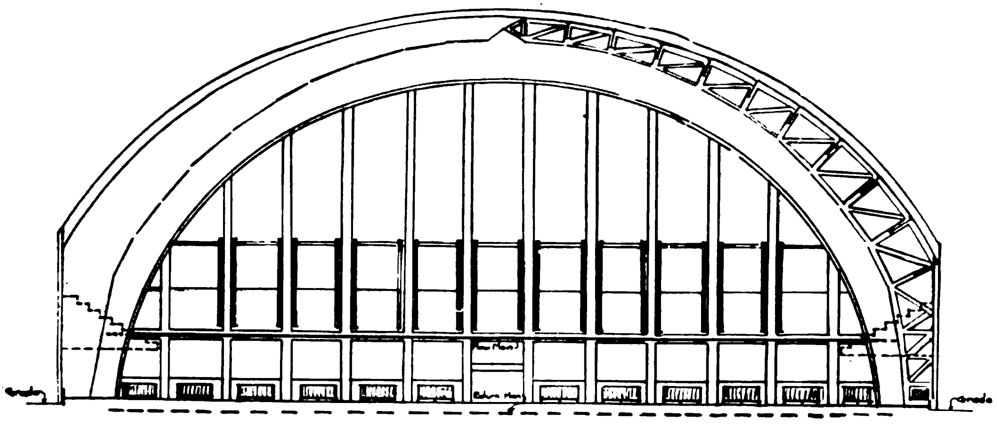
In all connections off the mains and to radiators, ample provisions have been made for expansion, both in the mains and in these connections.

There are 28 radiator units of 592 sq. ft. each for the sides, 24 units for the ends, averaging 294 sq. ft. for each unit, making a total of 23,632 sq. ft. of direct radiation.

For the sides of the building the radiators are supported on the trusses near the floor and on purlins approximately 40 ft. above the floor. For the ends, there is a line of radiators on the floor in each window bay and a second lot made up of ten 9B sections of American wall radiation connected end to end and placed alongside of the pilasters some 30 ft. above the floor. This arrangement provides practically a continuous line of direct radiation along the walls and ends on or near the floor, the immediate effects of which will be felt by those in the building. The second line of radiators, on purlins and alongside of the pilasters is designed to intercept currents of cold air which follow down the underside of the roof and to take care of glass losses at the ends.

METHOD OF SUPPORTING RADIATORS ON SIDES OF BUILDING.

In the direct radiation the features of special note are the methods of supporting the units above the mains along the sides of the building. These are made up of 116 sq. ft. of 23-in. 2 column radiators suspended by means of "U" bolts from a line of 2½-in. extra heavy steel pipe resting directly on the steel work of the building. These lines of supports were ordered 22 ft. long and are connected by passing each end into a 3-in. pipe sleeve, 6 ft. long; this gives a lap of 12 in. at



END ELEVATION OF ARMORY BUILDING, SHOWING THE 144 SQ. FT. RADIATORS ON FLOOR AND 90 SQ. FT. RADIATORS ON COLUMNS.

each end, and the 3-in. sleeve is secured to the 2½-in. pipe by through bolts.

The wall sections placed alongside of pilasters at the ends of the building are secured by bolts to specially prepared foundations behind the plaster.

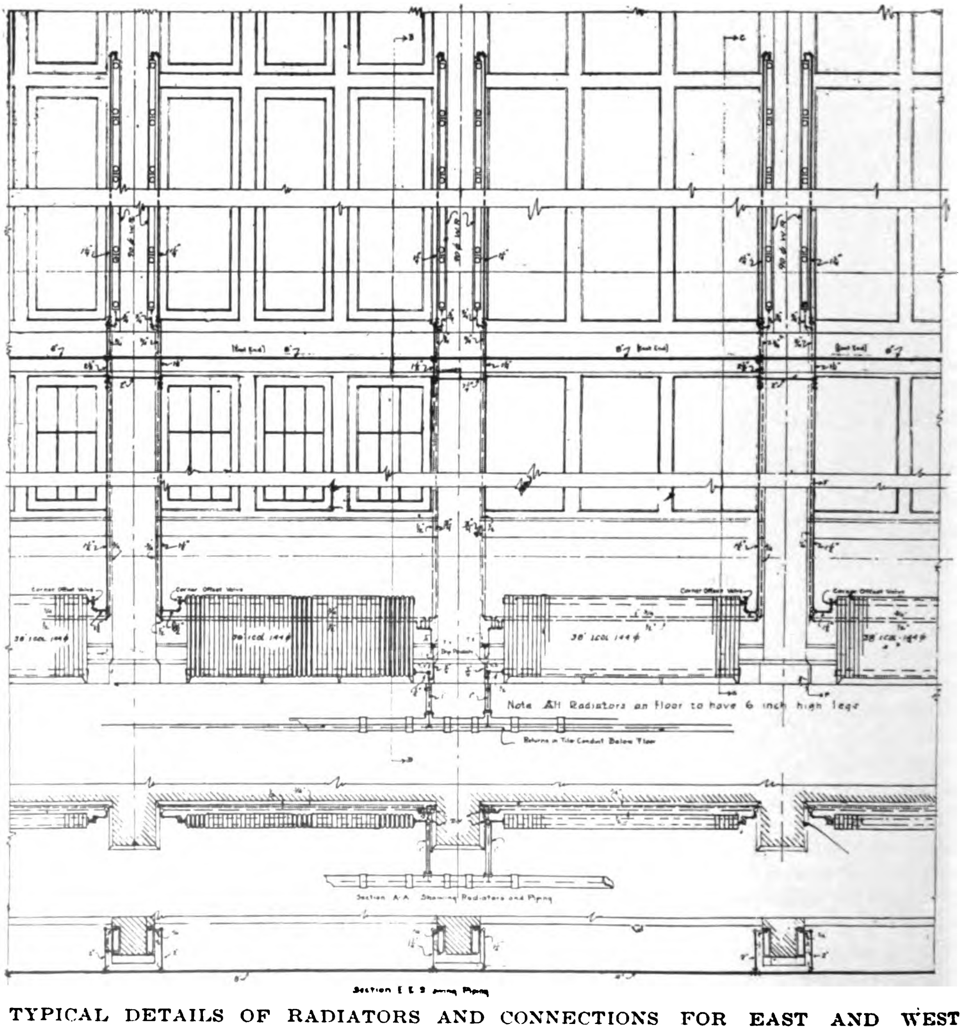
In the units for the different locations, the heights and number of columns were in each case selected to fill the entire space available, and at the same time have these units total the surface calculated for the entire building. This resulted in radiators 4 ft., 6 ft., 10 ft., and 12 ft. long. The units made up of 9-B wall sections are 24 ft. long, standing on end.

Each branch main is over 600 ft. long and the system operates very satisfactorily at 3 lbs. pressure without a pump.

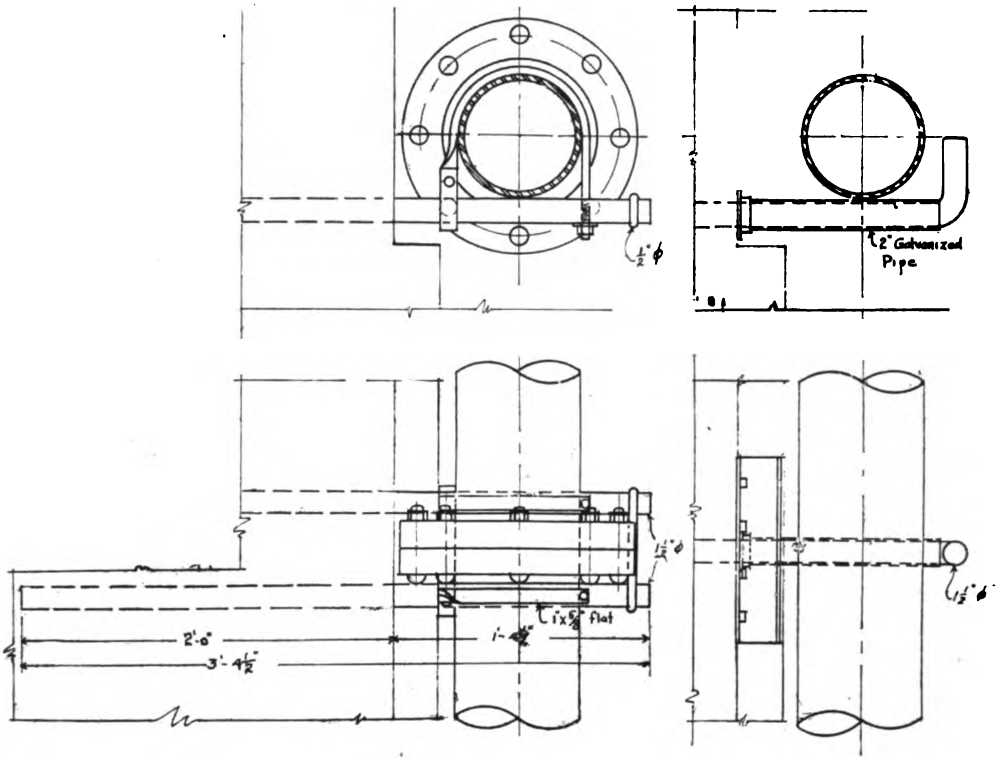
In the completed room, with balconies in place, all main piping and ducts and 90% of the drop pipes for the sides will be concealed. The balconies will conceal the main piping and ducts, and the drop pipes and branches off same are now concealed in the channels of the Bethlehem sections used in the trusses.

Calculations for Direct Cast-Iron Radiation.

The conditions to be met were: (1) to heat the building to a general temperature of 65° F. in zero weather, and it was not permitted to (2) interfere with any architectural features of the room nor (3) to locate the radiators elsewhere than on walls, columns, purlins and trusses.



TYPICAL DETAILS OF RADIATORS AND CONNECTIONS FOR EAST AND WEST ENDS, ARMORY BUILDING.



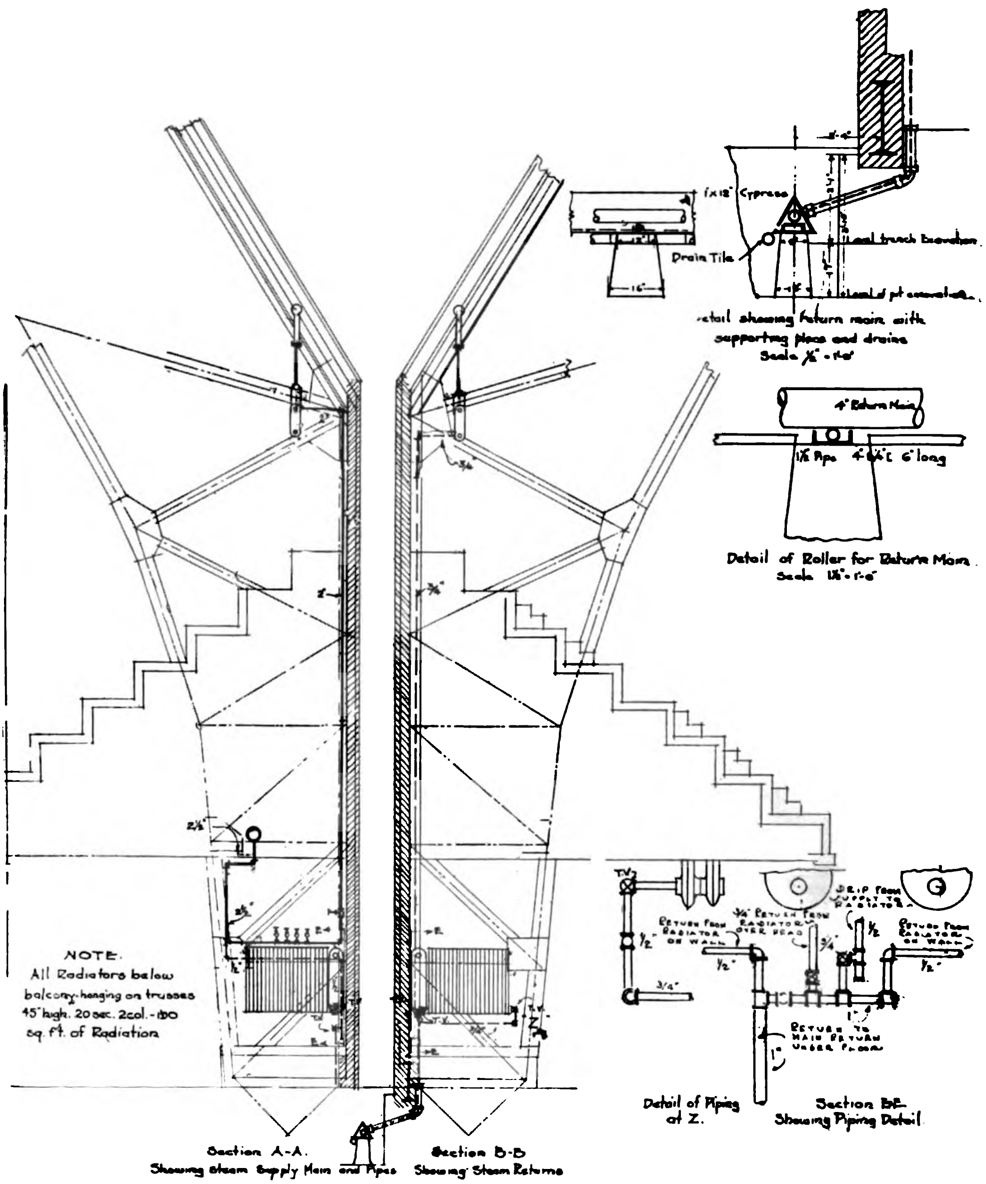
STEAM MAIN SUPPORT AND ANCHOR FOR EAST AND WEST ENDS.

To meet the first condition is a matter of installing *enough* surface, but the second placed limitations upon the first one, because there could be no special structure erected on which to place the units, and the dimensions of trusses, panels, columns, and purlins, were such that to respect the condition it was necessary to cover practically all available spaces with radiators of such dimensions that the radiating surfaces would be spread out as much as the spaces would permit, thereby resulting in a modified "hot-panel" arrangement. The third condition is a direct result of, and is demanded by the second one. Taking into consideration the fact that the units along the sides are practically 100 ft. from the center of the room, the necessity for depending upon convection currents is obvious. Temperature observations since the completion of the system, have shown a variation of less than 5° over the entire room at a plane 5 ft. from the floor and this small range is probably due largely to infiltration currents carrying the heated air across the room from the windward side. This fact was given due weight in determining the amount of surface required.

Also consideration was given the fact that the units could be so located that they would probably operate at very high efficiency and that while in standard practice, the time element for radiator efficiencies is based upon *one hour,* it is not always necessary to warm the room within this time, but a longer time may be assumed. In the present case the time element for direct radiation was assumed to be 90 minutes.

In figuring cubic contents, the room was conceived to be divided into spaces extending out to the edge of the balconies (yet to be constructed) and up to the roof in case of both the sides and the ends. The air in these spaces was figured to be heated from zero to 65° F. The main central zone of the building was figured to be heated through a range of 30° because it would be constantly tempered by convection or infiltration currents from the side spaces.

The wall and glass surfaces *below* bal-



TYPICAL DETAILS OF RADIATORS AND CONNECTIONS FOR NORTH AND SOUTH SIDES, ARMORY BUILDING.

conies were figured for a range of 70° and these surfaces above the balconies for a range of 65°.

The floor temperature was assumed to be 40° and heated to 70° in all cases.

In case of the roof, the temperature of the inside surfaces was figured to be 5° on account of strong currents from radiation provided nearer the floor, and in case of the central portion, the lower temperature was figured to be 25° on account of the "pocketing" effect of heated air from below. The accuracy of this latter assumption may be considered questionable, but since the installation of the system, workmen have found it to be uncomfortably warm up near the roof.

The constants for losses through all surfaces were taken from Professors L. A. Harding, and Homer Woodbridge, and increased to take care of what was considered to be conditions more severe

than those on which their constants are based.

The B. T. U. transmitted per square foot of radiating surface per *hour* was assumed to be 300 for cubic contents for units near the floor and on columns at the ends, and 260 for all other units; on a 90 minute basis this would give 450 for the former and 390 for the latter.

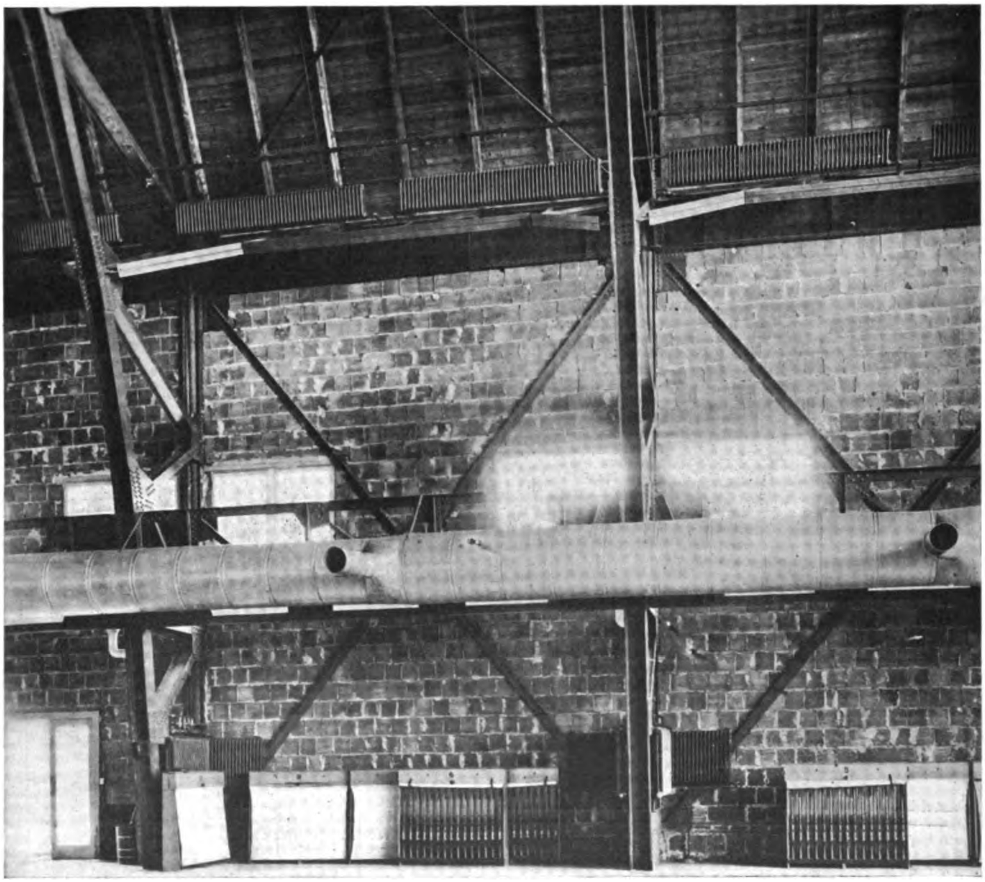
The following are the actual schedules, etc., as figured, "straight B. T. U. method" being used in all cases:

CUBIC CONTENTS.

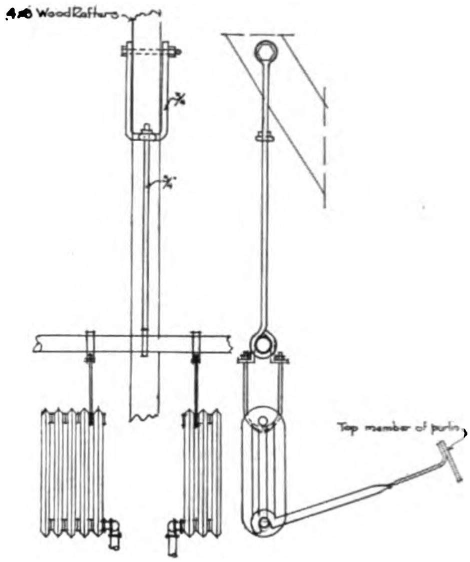
Total cubic feet in entire building		7,101,325
North side, below balcony	141,400	
North side, above balcony	348,200	
South side, below balcony	141,400	
South side, above balcony	348,200	
	979,200	
East end, below balcony..	50,880	
East end, above balcony..	106,320	
West end, below balcony.	50,880	
West end, above balcony.	106,320	
	314,400	
Total		1,293,600
Contents of remaining central zone of building		5,807,725

GLASS SURFACES.

North side	1,972	
South side	1,972	
	3,944	
East end, below balcony.	1,632	
East end, above balcony..	7,000	
West end, below balcony.	1,632	
West end, above balcony.	7,000	
	17,264	
Total glass surface		21,208



INTERIOR OF DRILL HALL, SHOWING SIX RADIATORS ON ONE TYPICAL TRUSS UNIT, ALSO PART OF MAIN AIR SUPPLY DUCT.



DETAIL OF CENTER SUPPORTS FOR RADIATORS ABOVE BALCONY.

WALL SURFACES.

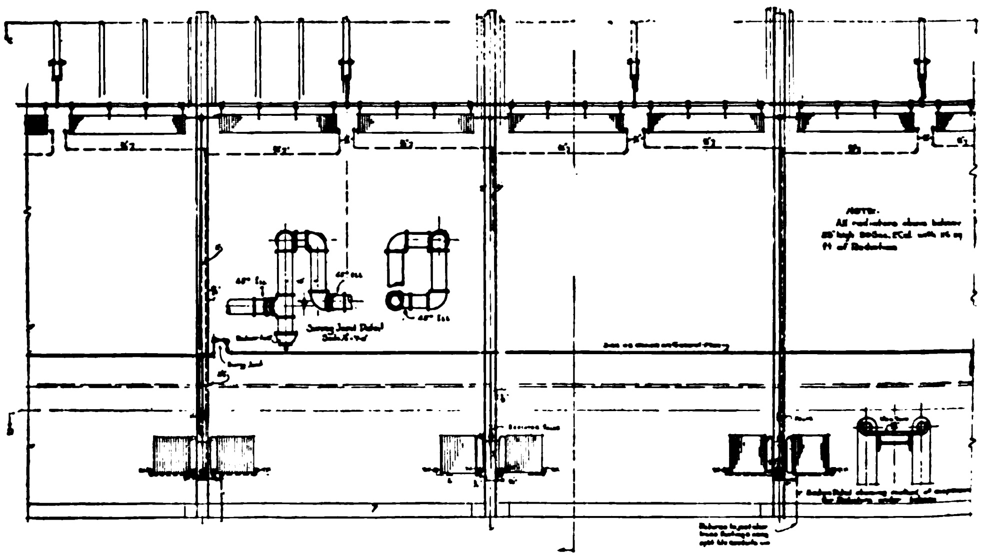
North side, below balcony	6,900	
North side, above balcony	8,200	
South side, below balcony	6,900	
South side, above balcony	8,200	
	30,200	
East end, below balcony.	1,500	
East end, above balcony.	6,500	
West end, below balcony.	1,500	
West end, above balcony.	6,500	
	16,000	
Total wall surface............		46,200

FLOOR SURFACES.

Total for building...............		88,000
North side, below balcony	9,152	
South side, below balcony	9,152	
	18,304	
East end, below balcony.	3,180	
West end, below balcony.	3,180	
	6,360	
Total floor surfaces...........		24,664
In central portion of building..		63,336

ROOF SURFACES.

Total for building (square feet)..		105,000
North side..............	16,240	
South side...............	16,240	
	32,480	
East end.................	1,800	
West end.................	1,800	
	3,600	
Total roof surfaces............		36,080
In central portion of building..		68,920



DETAIL OF NORTH AND SOUTH SIDES OF ARMORY BUILDING, SHOWING ARRANGEMENT OF COILS AND RADIATORS.

LOSSES AND RADIATION.

Cubic Contents.										Radiator Surface, Sq. Feet.
Below balcony—North	141,400	×	65	÷	55	×	450	=		371
Below balcony—South	141,400	×	65	÷	55	×	450	=		371
Below balcony—East	50,880	×	65	÷	55	×	450	=		134
Below balcony—West	50,880	×	65	÷	55	×	450	=		134
Below balcony—Central Zone..............	778,200	×	65	÷	55	×	450	=		2,044
Above balcony—North	348,200	×	65	÷	55	×	450	=		914
Above balcony—South	348,200	×	65	÷	55	×	450	=		914
Above balcony—East	106,320	×	65	÷	55	×	450	=		279
Above balcony—West	106,320	×	65	÷	55	×	450	=		279
Above balcony—Central Zone..............	5,029,525	×	30	÷	55	×	450	=		6,096
Total radiator surface..................										11,532

65° F. = Temperature Range.

GLASS SURFACES.

Below balcony—North	1,972	×	1	×	70	(a)	÷	450	=	302
Below balcony—South	1,972	×	1	×	70		÷	450	=	302
Below balcony—East	1,630	×	1	×	70		÷	450	=	254
Below balcony—West	1,630	×	1	×	70		÷	450	=	254
Above balcony—East	7,000	×	2	×	70		÷	450	=	2,180
Above balcony—West	7,000	×	2	×	70		÷	450	=	2,180
Total										5,472

Note—The losses through glass surfaces above the balcony were taken at double that for glass surfaces lower down because the wind has a relatively better chance to strike the upper surfaces.

WALL SURFACES.

Below balcony—North	6.900	×	0.4	×	70	(a)	÷	450	=	430
Below balcony—South	6,900	×	0.4	×	70		÷	450	=	430
Below balcony—East	1,500	×	0.4	×	70		÷	450	=	93
Below balcony—West	1,500	×	0.4	×	70		÷	450	=	93
Above balcony—North	8,200	×	0.4	×	65		÷	390	=	546
Above balcony—South	8,200	×	0.4	×	65		÷	390	=	546
Above balcony—East	6,500	×	0.4	×	65		÷	390	=	433
Above balcony—West	6,500	×	0.4	×	65		÷	390	=	433
Total radiator surface..................										2,998

a = temperature range.

FLOOR SURFACES.

Below balcony—North	9,150	×	0.2	×	30	(a)	÷	450	=	122
Below balcony—South	3,180	×	0.2	×	30		÷	450	=	43
Below balcony—East	3,180	×	0.2	×	30		÷	450	=	43
Below balcony—West	6,336	×	0.1	×	30		÷	450	=	433
Below balcony—Central Zone..............	9,150	×	0.2	×	30		÷	450	=	122
Total										763

Note—The losses for surfaces below the balconies were taken to be double those for the other floor surfaces because these surfaces are near the wall and, therefore, have a better chance of being cooled by air currents from the outside.

ROOF SURFACES.

North side	16,240	×	0.2	×	60 (a)	÷	450	=	433
South side	16,240	×	0.2	×	60	÷	450	=	433
East side	1,800	×	0.2	×	60	÷	450	=	48
West side	1,800	×	0.2	×	60	÷	450	=	48
Central Zone	68,920	×	0.2	×	40	÷	450	=	1.225
Total									2.187

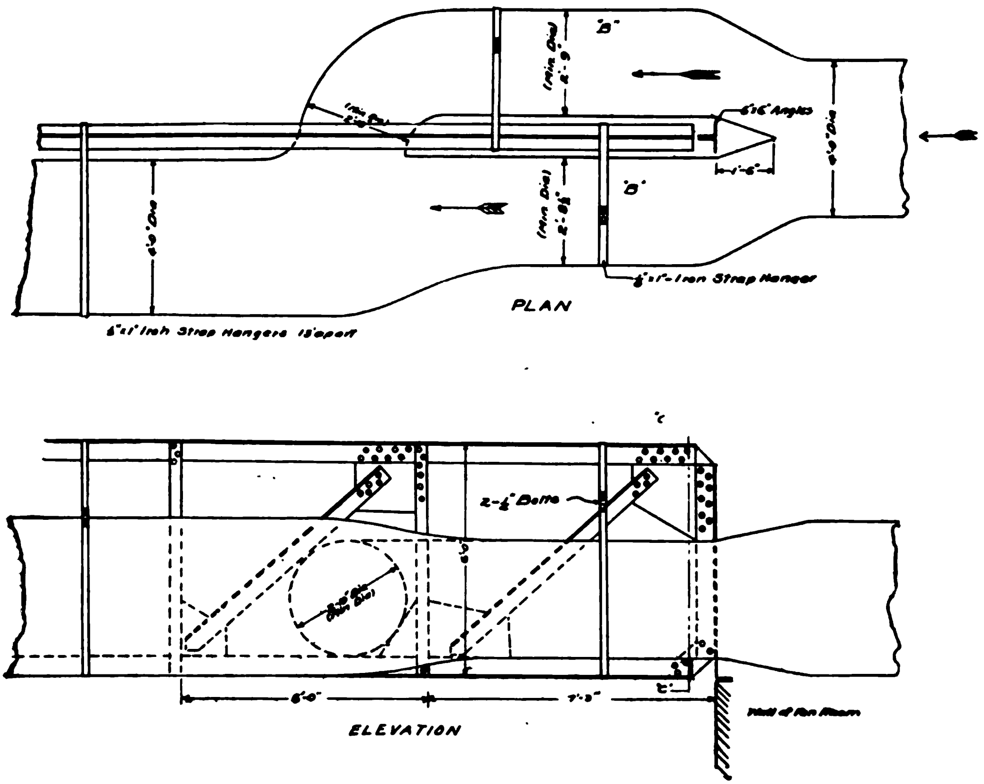
TOTAL RADIATION COMPUTED.

	Sq. Feet.
Cubic Contents	11,532
Glass	5,472
Wall	2,998
Floor	763
Roof	2,187
Radiation Computed	22,952
Radiation Installed	23,632

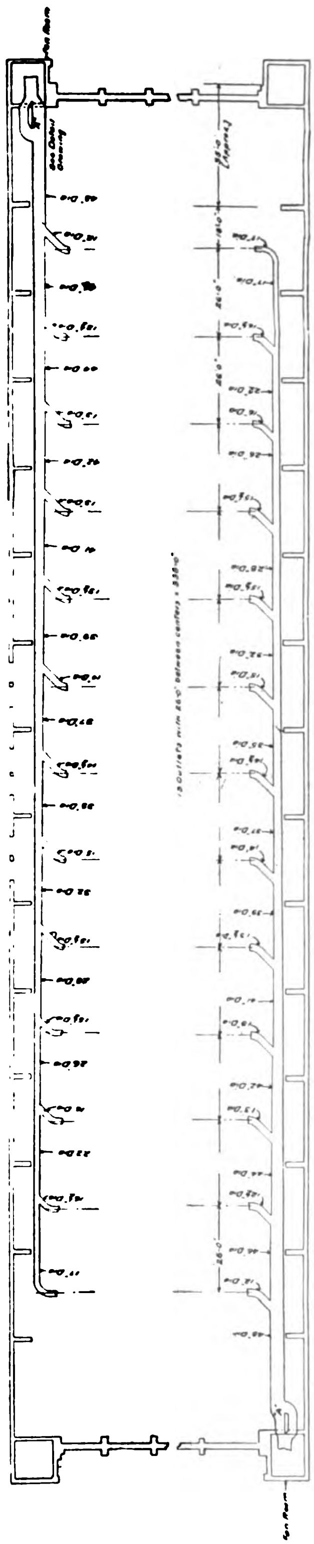
Air Recirculating System.

In order to recirculate the air in the building, or to furnish fresh air should this be required, as well as to produce more active circulation or movement of air at the longitudinal center of the building, two fan units with coils, and duct work are installed, one at the northeast and the other at the southwest corner of the building. Each unit is designed to handle 33,000 cu. ft. of air per minute against a total pressure of 1.35 in. of water, velocity of fan at outlet, 2750 ft. per minute.

The duct into which each fan delivers is 48 in. diameter at the fan and decreases to 18 in. at the last outlet.



DETAILS OF AIR DUCT AT "A," ARMORY BUILDING.
(See plan of Ventilating System.)



PLAN OF VENTILATING SYSTEM FOR ARMORY BUILDING, UNIVERSITY OF ILLINOIS.

Each duct is 380 ft. long and has thirteen outlets, 12 in. to 18 in. diameter, all outlets being fitted with adjustable dampers. The basic data for the design of these ducts are: coefficient of friction 0.0045 (0.0037 + 25%); velocity at last outlet 1600 f.p.m.; volume of air for each outlet 2500 c.f.m. The duct was designed for equal friction pressure loss per foot of length, following the method of Professor L. A. Harding, to whom credit is due for this design.

The high velocity at duct outlets is used in order that the effects might be felt at the center of the building, which is 90 ft. from the duct outlets.

In order to overcome any possible "chimney effect" all outlets are inclined to a line 5 ft. from the floor at the center of the building.

The "roar" at duct outlets is minimized by omitting grills for these outlets.

In the installation of fans, heaters, and ducts, structural conditions necessitated locating the heaters on top of the fans, also splitting the fan outlet to the main duct to obtain the required outlet area.

The heaters are made up of two sections for each fan, 7 ft. wide, 8 ft. high and containing 1168 lin. ft. of 1 in. pipe per section; total for both fans, 4672 lin. ft. Approximate cast iron equivalent, 9500 sq. ft.

The entire system is under Powers temperature control, there being 12 thermostats for direct radiation and two duct thermostats for the fan system.

The accompanying sketches illustrate such features of this problem as seem to be sufficiently out of the ordinary to be of interest.

The heating contractors are Carson-Payson Company, Chicago; fans and duct work, New York Blower Company, Chicago; pipe covering, Smith-Totman Company, Chicago; thermostatic traps, Illinois Engineering Company, Chicago; temperature control, Powers Regulator Company, Chicago.

The principal parts of all work are exposed, and the workmanship and operation of all parts of the system are satisfactory. The system has been in operation one season.

The system is to be subjected to complete tests, to obtain temperatures and amount of condensation, as soon as there is an opportunity.

The Measure of Comfort in Factories

CONSTRUCTION AND USE OF THE KATATHERMOMETER.

BY JAMES A. SEAGER.

It is becoming increasingly realized today that satisfactory manufacturing operations depend very largely upon the reasonable comfort of the worker; that a man or woman cannot carry out the operations involved in a factory process unless physical conditions are such as to make attention to the work possible without distraction. Particularly is this the case where the work involved demands skill either of body or brain. From such a standpoint, the search for the comfort of the employe is not an amiable impulse, but a necessity dictated by one of the elementary laws of success.

For this reason the Katathermometer, made by James Hicks of Hatton Garden, London, is in reality a measure of comfort in factories and offices where it is applied, and is therefore also a measure of efficiency in manufacturing and commercial operations. It owes its origin to Professor Leonard Hill who, working from the principle that comfort and good health depend very largely on the rate of heat loss and evaporation of moisture from the skin and upper air passages, upon the vascular condition of these parts and the excitation of sensory nerves therein by pleasantly cool, moving air, developed the instrument about to be described.

EFFECTS OF CONFINED WARM AIR.

In confined warm air massive infection occurs by the spraying of saliva. The inhalation of trade dust, particularly gritty stone and metal, and the indulgence in alcohol, lessens immunity to disease. By breathing warm air or convected heat the nasal mucous membrane is swollen and the air way is obstructed while convected heat helps to bring about infection. On the other hand, cool air and radiant heat bring the skin into play and keep the nose in a healthy state.

The importance of the above remarks may be practically demonstrated by quoting some figures obtained from the supplementary volume to the 65th Annual Report of the Registrar General (Great Britain) published in 1908. In this some comparative figures for mortality from phthisis among workers are given, the difference between those for open air employments and town and factory occupations being very marked. Taking first of all the open-air workers the comparative figure for railway engine drivers and stokers is 63; that for gamekeepers, 73; agriculturalists, 79; farm laborers 82; gardeners and nurserymen 83, and fishermen 96. Contrasting these with town and factory workers we have that while the figure for the chemical manufacturers is 96, that for printers is 290; for furriers and skinners, 314; brush makers, 314; makers of tools, scissors and the like, 353, messengers and porters (otherwise than railway), 368; costermongers and hawkers, 516; inn and hotel servants, 533; while for inn and hotel servants in London the figure is 667. Thus the mortality of the hotel servants from consumption is about ten times that of the engine drivers and eight times that of agriculturalists. Coal mines and chemical factories have a low phthisis mortality, probably owing to the necessity for good ventilation therein. The argument may be strengthened by reference to another authority. According to Hindhede, in Denmark out of every 10,000 people 2,700 die in Copenhagen between the years of 40 and 60, who, if living in the country, would die between the years 60 and 90.

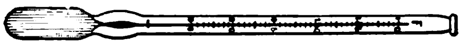
RATE OF HEAT AND INFLUENCE OF MOVING AIR IMPORTANT FEATURES.

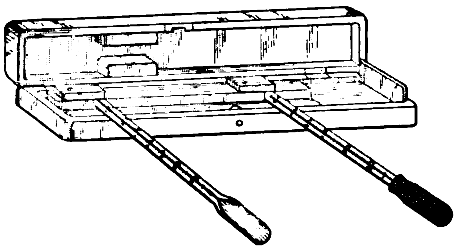
It should be remembered in connection with the above that the ordinary wet and dry bulb thermometers give no indication of the rate of heat loss and of the important influence of moving air, these being, as shown above, factors of primary importance in securing comfort. This is demonstrated by the fact that in a closed chamber heated to say 85° F., dry bulb, and 80° F. wet bulb, so long as the air is well stirred by a fan the atmosphere feels cool and comfortable. On stopping the fan, however, while the

change in temperature indicated by the thermometer is almost imperceptible the atmosphere at once becomes unpleasantly warm and uncomfortable. The katathermometer is therefore designed to take account of these factors, or, in other words, to indicate the sensation actually experienced by the human body.

CONSTRUCTION OF KATATHERMOMETER.

In construction this instrument consists of two large-bulbed spirit thermometers the stems of which are marked at 110° F., 100° F. and 90° F. Another





PROFESSOR LEONARD HILL'S KATATHERMOMETER.

mark is made just above the bulb in each case. In one thermometer the bulb is covered with a finger-stall taken from a muslin glove, this being the wet-bulb instrument. The finger-stall holds the least amount of water sufficient for taking an observation. The bulb of the other thermometer is uncovered.

In use, both bulbs are immersed in water at about 110° F. up to the mark just above the bulb. When the menisci have reached about 110° F., the instruments are withdrawn. The bare bulb is rapidly dried on a soft cloth, while the excess of water is jerked off the bulb and covering of the other thermometer. It should be noted, by the way, that if the column of spirit is not continuous the instrument is jerked till this condition is obtained, or the bulb is heated until the spirit rises into the top reservoir. After immersing and drying as indicated the instruments are rested in clips provided and the time required for the meniscus of each instrument to drop from 100° to 90° F. is taken with a watch. If a stop watch is used, when the falling meniscus reaches 100° F. the watch is started, and stopped when the meniscus reaches 90° F.

In this way the rate of cooling of the wet and dry instruments at about body temperature is found. Further readings may be taken with the instruments exposed to or screened from a source of radiant heat, or exposed to or screened from wind or draft, or again with a thick knitted finger-stall placed over the bulb to imitate the effect of clothes. In this way the various conditions affecting the comfort of the human body may be studied. When the finger stall just mentioned is damped, its efficiency is greatly diminished, illustrating the cooling effect of damped clothes. The effect of the color and texture of clothes may also be demonstrated.

A white finger-stall allows the instrument to cool when exposed to sunlight much more quickly than a dark finger-stall, as the latter absorbs the light rays and converts them into heat rays. This is what would be expected by anyone knowing the value of white clothes in tropical or semi-tropical areas.

HOW A STANDARD OF VALUE WAS REACHED IN CONNECTION WITH THE READINGS.

It may be interesting to give some account of the way in which some standard of value was reached in connection with the readings obtained by this instrument. The graduation of the Katathermometer has, of course, to be empirical, and the process was effected by taking readings out of doors on an ideal spring day in sunshine, with a gentle, cool breeze. The shade temperature was 62° F. It was then found that the wet bulb fell from 100° F. to 90° F. in 45 seconds, while the time taken for the dry bulb was 2 minutes 25 seconds. Screened from the sun, the dry bulb fell in 1 minute 46 seconds. With a thick knitted glove, the wet bulb fell in 1 minute 50 seconds, the dry bulb falling in 6 minutes 27 seconds. Screened from the sun, the dry bulb fell in 4 minutes 23 seconds. The radiant heat of the sun produced a marked effect on the dry bulb enclosed in the thick dark glove, and the observer in the same degree felt the warmth of the sun on his back. It may be noted that the variation of the temperature in different parts of

the skin contributes to comfort and well-being. This constitutes an advantage of radiant heat, and a disadvantage of systems in which air is heated by convection.

In a room, on the same spring day, with the window wide open, under pleasant conditions, the air moving, and no fire, the wet bulb fell in 58 seconds, while the dry bulb fell in 2 minutes 43 seconds. On another ideal spring day with a shade temperature of 63° F. the wet bulb fell in 40 to 51 seconds, while the dry bulb fell in 2 minutes 10 seconds to 2 minutes 40 seconds. The times varied with the strength of the breeze and the instruments showed how the stimulation of the skin varies with the breeze out-of-doors. Shielded from the sun the wet bulb fell in 35 seconds, the dry bulb falling in 1 minute 28 seconds.

On another spring day, which was not ideal, in a cold, raw wind with spots of rain falling, the wet bulb fell in 24½ seconds, the dry bulb falling in 55½ seconds. Inside the room, with open fire and comfortably warm, the wet bulb fell in 1 minute 9 seconds, the dry bulb falling in 3 minutes 5 seconds. On another day with a cold wind blowing, with a temperature of 54° F. and when an overcoat was felt to be necessary the wet bulb fell in 25 seconds and the dry bulb fell in 51 seconds. With the thick glove on the instrument the time of fall for the wet bulb was 55 seconds and for the dry bulb, 2 minutes 5 seconds. In a room with no fire and with windows shut the times were 53 seconds and 2 minutes 13 seconds for the wet and dry bulbs, respectively. Hence the effect of the shelter afforded by the walls of the room was about the same as that given by the thick glove outside. In a room with a fire and no windows open, at a temperature of 60½° F., the atmosphere being comfortable but slightly too windless, the wet bulb fell in 1 minute 7 seconds while the dry bulb took 3 minutes 8 seconds.

OTHER RESULTS OF TESTS.

On another day with a strong fresh wind blowing and a temperature of 60½° F. the wet bulb fell in 31½ seconds and the dry one in 1 minute 21 seconds. In a more exposed place the time for the wet bulb was 26 seconds, and for the dry bulb 49½ seconds. With the thick glove on, the times for the wet and dry bulb were 1 minute 4 seconds and 3 minutes 3 seconds. These figures show how relatively great is the cooling effect of wind, and the protection afforded by clothes. Other interesting tests were as follows: On a mild day with slight rain and little breeze, with a temperature of 52° F. the time was 34 seconds for the wet and 1 minute 22 seconds for the dry bulb. On a warm May day in a room with windows wide open the wet bulb fell in 1 minute 1 second, the dry bulb falling in 3 minutes 7 seconds. Out of doors in the warm sunlight the times were 44 seconds and 4 minutes 47 seconds for the wet and dry bulbs. In a railway restaurant car where the atmosphere felt unpleasantly warm and windless, the wet bulb fell in 1 minute 5 seconds while the dry bulb took 4 minutes 10 seconds. In a room heated by anthracite stove to 70° F. (dry) and 62° F. (wet), and unpleasantly warm, the wet bulb fell in about 1 minute 30 seconds and the dry bulb took 4 minutes 30 seconds to five minutes.

The last result is especially interesting. In a room heated by an anthracite stove, which chiefly provides convected heat, the effect on the Katathermometers of screening them from the stove is very slight. In the same room heated by a modern gas fire fitted with a flue, giving radiant heat, screening makes a very great difference, and the instruments show that by such a fire the parts of the room and its occupants are unequally heated and conditions of uniformity avoided. In a chamber heated to 84° F. dry bulb and 77° F. wet bulb, the dry bulb Katathermometer fell in 7 minutes and the wet bulb in 2 minutes 15 seconds. On putting on a fan the dry bulb fell in 3 minutes 39 seconds and the wet bulb in 1 minute 33 seconds, while the ordinary thermometer scarcely varied.

WHAT THE RESULTS SHOWED.

From the above tests and results given by Mr. Hicks the conditions attendant on the healthy conditions of rooms, factories and the like can be gauged. These are that a room is best heated by an open fire or modern gas fire, that is to say, by sources of radiant rather than

convected heat, and ventilated with fresh outside air, gently moving, and so kept as near as possible to the conditions of an ideal spring day. The nearer the approximation to these conditions that can be obtained, the better are the conditions as regards health, comfort and working efficiency. The air used for ventilation should not be heated, as heat gives the same discomfort as desert air or a close day. The heating and ventilation of rooms should be arranged so that the Katathermometer wet bulb falls from 100° F. to 90° F. in about one minute and the dry bulb in about three minutes. These times may with advantage be less—for example, 50 seconds and 2 minutes 30 seconds, respectively—but they should not be much exceeded. In view of the importance of physical comfort in shops, factories, offices and buildings of all description, the development of a means of definitely grading the conditions of such comfort in terms of physical quantities is a remarkable development warranting the reference here given.

Dust and Bacteria Content of City Air

With Special Reference to Sub-Basements, Fresh Air Schoolrooms, Street Cars and Open Spaces.

By Melville C. Whipple,
Instructor in Sanitary Chemistry, Harvard University.

(From a paper read before the American Public Health Association and published in the Association's "American Journal of Public Health.")

In view of the fact that there is only a small amount of published information which gives reasonably accurate figures for the numbers of dust particles and bacteria in the air, this paper is presented as a compilation of the results obtained over a fairly wide range of conditions.

METHOD OF PROCURING SAMPLES.

For securing samples of air for dust and bacterial analysis the device manufactured by Wallace and Tiernan, 136 Liberty Street, New York City, has been used. It consists of a wooden box 9 in. x 12 in. x 8 in., within which is either a direct or alternating current motor that operates on any 110-volt circuit. A small pump is operated by the motor and this draws in air from the outside of the box through a glass adapter tube that fits into a metal receiving cup. A tight joint is made by means of a rubber gasket. The adapter tube contains a ½-in. layer of sand for the retention of bacteria and this is later washed out from the tube with sterile water. For the collection of dust particles a ½-in. lever of resorcinol crystals is employed. The crystals are later dissolved in perfectly clean water and counted under the microscope with the use of a 16 mm. objective. Particles from one micron upward can be enumerated in this way. The employment of this method calls for extreme care and scrupulous cleanliness in the preparation of apparatus and the subsequent procedure. Consistent results cannot be obtained unless such precautions are taken.

Examination of dust by the method already outlined, using the microscope, does not reveal the presence of particles smaller than about 1 micron, 0.001 mm. This is unfortunate, as it may be that different atmospheres vary greatly in their content of particles smaller than this, particles that might almost be said to be "colloidal" in size. Likewise those atmospheres that are most sought for by mankind, in the belief that there are benefits derived from life in them, are cleaner than those that envelope populated communities. Determinations of dust made by the writers in the summer season showed 18,000 particles per cubic foot in the air over Long Island Sound, 27,000 at the fifty-seventh story of the Woolworth Building in New York at a time when the street air showed 221,000, and 25,000 particles after a heavy summer shower in Cambridge, Mass., where the normal dry weather content was 200,000 or over. Attention is called to the close agreement between these three determinations, representing as they do the dust in air under conditions of obvious cleanliness.

TABLE I.—SUMMARY OF ANALYSES OF AIR MADE AT LAWRENCE HALL SCHOOL.

Date 1914.	Dust particles per cu. ft. Outside air.	Kindergarten.	First grade.	Bacteria per cu. ft. Gelatine at 20° C. Outside air.	Kindergarten.	First grade.	Agar at 38° C. Outside air.	Kindergarten.	First grade.
Jan. 8	......	......	140,000	..	..	16	..	..	7
Jan. 16	68,000	185,000	228,000	3	43	27	0	7	13
Jan. 28	98,700	107,000	147,000	0	27	50	0	8	15
Feb. 26	264,000	311,000	363,000	10	10	20	0	13	33

Carbon dioxide determinations made on Jan. 28 gave the following results:

Outside air = 3.5 parts per 10,000.
Kindergarten = 4.25 parts per 10,000.
First grade = 5.0 parts per 10,000.

Temperature and Humidity Readings.

Date 1913-14.	Outside air. Temperature F°.	Relative humidity per cent.	Abs. humid. grains cu. ft.	Kindergarten. Temperature F°.	Relative humidity, per cent.	Abs. humid. grains cu. ft.	First Grade. Temperature F°.	Relative humidity, per cent.	Abs. humid. grains cu. ft.
Dec. 12	33.0	60	1.316	57.5	39	2.059	56.0	40	2.006
Dec. 18	42.5	75	2.340	63.0	45	2.857	58.0	52	2.792
Jan. 8	36.0	60	1.474	50.0	39	1.590	49.0	40	1.574
Jan. 16	26.0	73	1.185	60.5	30	1.753	56.0	35	1.756
Jan. 28	45.5	79	2.746	59.5	50	2.825	57.5	53	2.798
Feb. 13	12.0	47	.402	60.0	15	.861	...	..	....
Feb. 26	35.5	28	.662	62.0	16	.982	58.5	21	1.148

CONDITIONS IN A SMALL FRESH AIR SCHOOL.

In Table I are given the results of several determinations of dust and bacteria made in a small fresh air school in Cambridge, Mass. There were two rooms, one for kindergarten instruction, the other for first grade work. The dimensions of the first were 21 ft. x 40 ft. and of the latter 10 ft. x 31 ft. Ceilings were 13 ft. high. There was no mechanical system of ventilation and air was taken into the room through several large windows and transoms, principally the latter, along one side of each room. A temperature between 50° and 60° F. was maintained throughout the winter. In each room there were about twenty small children and the teacher, the unit volume of air space accordingly being about 500 cu. ft. per person in the kindergarten and 200 cu. ft. in the first grade.

In all cases the dust particles and the bacteria were more numerous in the air of the rooms than in that of the outside air, varying, no doubt, with the amount of disturbance in each room. Likewise, with one exception, the first grade room showed higher counts than the kindergarten room. The smaller volume of air per occupant in this room accounts for this fact. The actual number of children was about the same.

These results are given merely as an illustration of the greater number of bacteria and dust particles that are present in the indoor air of one class of occupied rooms. The numbers are not excessive for schoolrooms, and are, in fact, considerably lower than the average results obtained by Winslow in the New York City schools. This might be expected, as one of the advantages of a fresh air school, the object of which is to provide a rapid change of air between the inside and outside atmospheres.

An interesting sidelight upon this particular fresh air school is the fact that the teachers went through the entire winter without colds, although they had been subject to them in previous years while teaching in the ordinary schoolrooms where mechanical systems of ventilation and higher temperatures were in use. The cool temperature of the rooms, as shown in the table, may have been quite as much of a factor as was the ventilation in maintaining the good health tone.

QUALITY OF THE AIR IN SUB-BASEMENTS.

How best to improve atmospheric conditions in the basements and sub-surface floors of buildings has long been a prob-

lem with department store proprietors. It has been hard to approach the improved standards applied to the upper floors, owing to the fact that mechanical means must be employed to change the air, and these must be on a scale larger than ordinarily used because of the great volumes of air to be handled, the absence of air movement below the street surface, the heat radiated from artificial lighting, and the larger crowds that frequent the basement departments. Table II gives the results of some studies in a large Boston store, where considerable attention has been given to the ventilation of the basement floor and the mezzanine floor just above it. The latter is described in the table as the "basement balcony." Washed air taken from the roof is supplied to these floors. It does not furnish the entire supply, however, as the exhaust system handles a volume several times larger, the difference being made up by leakage inward from stairways, wells and other openings.

The number of dust particles at various places in the basement was considerably higher than in the incoming washed air or the outside air. Microscopical examination showed that many of the particles were of fibrous structure. The handling of clothes and dry goods and the contact of large numbers of people in passing about the store would naturally give rise to a considerable amount of dust of this character.

There was a striking difference in the number of bacteria in the washed air and that in the store. A considerable increase was shown both in the forms growing at 20° C. and those growing at 37°.

It will be seen that the figures given for the store in Table II exceed those given for the fresh air school in Table I. This serves as an illustration of the way in which indoor air becomes unclean by use, the degree depending upon the extent of usage and the frequency of change. The basement referred to above had an elaborate installation for renewing its atmosphere and was fairly comfortable as to temperature and humidity. The ventilation system did not accomplish as perfect results, however, from the standpoint of air cleanliness. The figures given for dust and bacteria are slightly in excess of the average results given by Winslow for New York City schools.

DUSTY CONDITIONS IN STREET CARS.

During the routine of life in large cities there is probably no other place where the population mingles in closer personal contact, or under more abnormal conditions of ventilation, than in the cars of our transportation systems.

The air in street cars is subject to unusual contamination from two sources: first, from the large number of persons occupying a given cubical space, and, second, from the streets over which the cars pass.

With the idea of obtaining information relative to the dust and bacteria content of air in street cars, some studies were made on the line of the Boston Elevated Railway Co., running between Harvard Square in Cambridge and Pleasant Street in Boston. The results are given so far as obtained, and are of interest as showing the conditions at the particular time

TABLE II.—SUMMARY OF ANALYSIS OF AIR TAKEN FROM THE BASEMENT AND BASEMENT BALCONY IN A DEPARTMENT STORE, BOSTON. APRIL 3, 1914.

Hour.	Location.	Bacteria per cu.ft. Gelatine at 20°.	Agar at 38°.	Dust particles per cu. ft.	Temperature. Dry bulb, Deg. F.	Wet bulb, Deg. F.	Relative humidity, per cent.	Remarks.
11.00 a.m.	Intake of air washer....	33	3	137,000	...	...	..	....
11.10 a.m.	Intake of air washer....	..	..	......	54.5	46.0	50	Air taken in at roof
11.30 a.m.	Washed air from washer	17	3	68,000	58.5	51.5	61	Sample in duct
1.05 p.m.	Basement, N. E. corner..	150	10	262,000	60.5	47.5	34	Near freight elev't'rs
1.45 p.m.	Basement, N. W. corner.	200	53	423,000	70.0	54.0	33	Near Exit CC
1.55 p.m.	Basement, S. W. corner..	..	..	......	70.0	53.5	31	Near Exit DD
2.10 p.m.	Basement, S. S. center..	223	67	476,000	...	...	..	....
2.15 p.m.	Basement, S. S. center..	..	..	......	72.0	54.5	29	Ladies' suit dept.
3.00 p.m.	Balcony near stair well.	160	23	321,000	...	...	..	....
3.05 p.m.	Balcony near stair well.	..	..	......	73.0	57.0	35	North Side
3.15 p.m.	Balcony near restaurant.	..	..	......	74.5	58.0	34	South Side
3.30 p.m.	Balcony, S. W. corner...	90	10	388,000	...	...	..	....
3.30 p.m.	Balcony, S. W. corner...	..	..	......	69.5	52.0	27	Near Exit DD

and place at which determinations were made.

The line in question extends over four miles of the Boston Elevated Railway system, approximately half of the distance being surface line, the balance being divided between one of the Boston subways and a long viaduct passing over the Charles River and a portion of Boston. The cars in use were the large semi-convertible type; known as 4A2 and having closed vestibules and cross seats with a center aisle. Air was admitted to the cars by means of two deck-sash ventilators at either end, and by means of twelve curtain ventilators along the roof of the car, six of which were always open, the remaining ones closed. Samples of the air were collected at the center of the car. The results of analyses for dust particles and bacteria are given in Table III and are shown graphically in diagrams 1 and 2. From eight to ten minutes were required for the taking of each sample, during which time the car was moving. The portion of the route over which the car moved during the taking of each sample is indicated in the diagram and in the tables the maximum and minimum numbers of passengers are given for each portion of the route.

Diagrams 1 and 2 show the route over which samples were taken, the character of the route at different points, and the approximate distances between stations. The figures for bacteria and dust appear above and below the representation of the route, and the line under each of them indicates the distance over which the sample was taken.

Comparison of the two diagrams shows a decided difference in the number of bacteria and dust particles on a damp and on a dry day, the latter showing the higher results. The figures presented are much higher than those given for samples collected in other places mentioned in this paper. In one case the dust particles numbered 3,415,000 per cubic foot. This was in a section of Cambridge where a large force of men was engaged in removing the winter's accumulation of street dirt.

SUBWAY AIR LESS CLEAN THAN OUTDOOR AIR.

Judging from the rather limited number of determinations made, there is a tendency for the subway air to be less clean than the outside air over the streets. In general, higher results were obtained on portions of the route lying in the subway. The dust particles collected in the

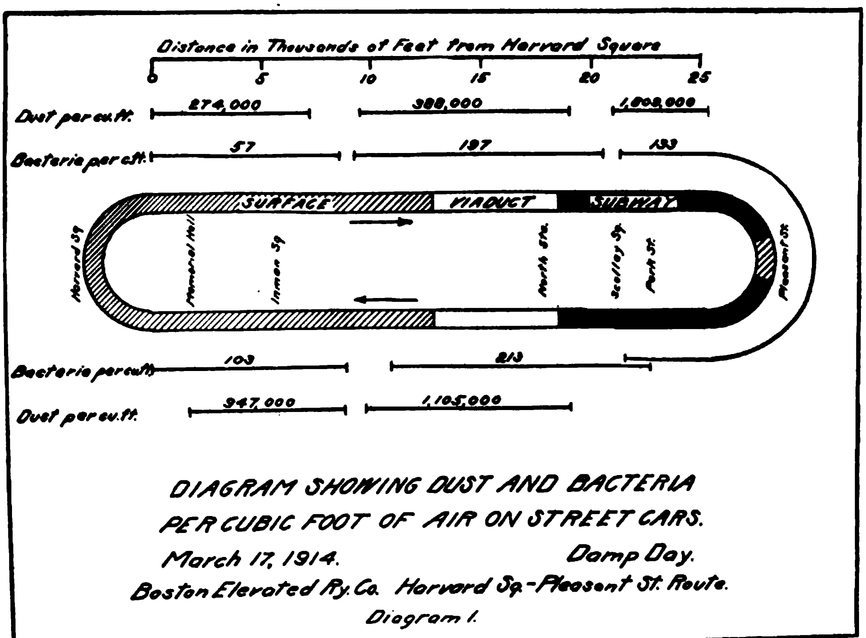


DIAGRAM 1—DUST AND BACTERIA CONDITIONS ON A STREET CAR ON A DAMP DAY.

subway had a smaller average diameter and under the microscope were darker in color. The work of Soper in the New York subways has shown that a very considerable amount of metallic dust is present in subway air. This results from the wearing down of rails, wheels and brake shoes. Samples taken on the viaduct or in passing over it might be expected to give lower results on account

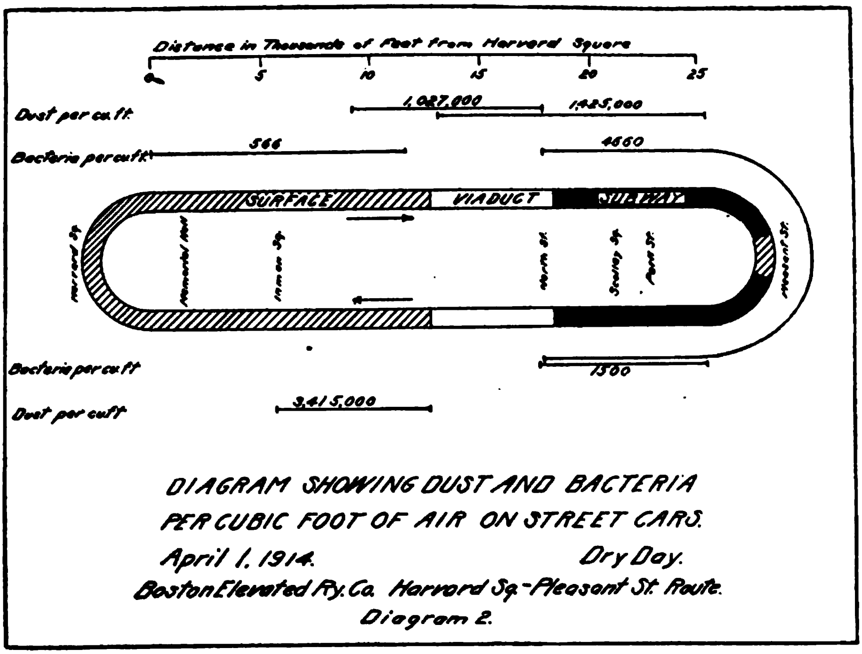


DIAGRAM 2—DUST AND BACTERIA CONDITIONS ON A STREET CAR ON A DRY DAY.

of the greater purity of the atmosphere; but in passing from a rather dirty section of Cambridge in one direction, and from the subway in the other direction, with doors and windows closed, there was a considerable lag in the change of atmosphere within the cars.

In connection with Table III it will be noticed that the dust and bacteria content of the outside air at Pierce Hall, as registered on the days when samples were taken in the cars, was very much lower. This might be expected when consideration is given to the agitation surrounding the movements of street cars and the amount of dust and dirt that is brought into them by passengers.

The variation from day to day in the dust content of city air in a place removed from the influences of car traffic is illustrated by the figures given in Table IV. The results are for an eleven-day period following shortly after April 1, 1914, the date of the street car observations given in Diagram 2. A wide range of weather conditions is covered by the period. Each sample examined was a composite one made up by collecting the dust at three or four different intervals during the day.

In general, the figures in the table show that dust particles were most numerous when the streets were dusty and the wind movement great. Exceptions to this occurred on April 8, a foggy day with no wind, and on April 12 and 13, when there were high winds and fair weather. It is an observed fact that on quiet days with high humidity conditions a large amount of soot and dirt is deposited from city atmosphere. This may explain the result for April 8. The low results of April 12 and 13 were coincident with a shifting of the wind to northerly directions and a lowering of temperature. This followed a very light rain on the night of April 11. The movement of large volumes of air from northerly points nearly always results in a clearing of the atmosphere in Cambridge.

A general inspection of all the results

presented in this paper shows that, although the dust and bacteria contents of air in different places, both indoors and out-of-doors, vary from day to day, there are distinct differences that mark the increased cleanliness of one place over another. These differences are measurable by the methods that have been described. Outdoor air may be said in nearly all cases to be cleaner than the same air after use in occupied places. Its initial purity will depend upon two things, the source from which it is taken, and the meteorological conditions prevalent.

The dust and bacteria in the air of occupied places has been shown to vary greatly with the character of the place. The amount is, of course, influenced by a great many factors. The cleanliness of inside air may be judged by the total numbers of dust particles and bacteria present, regardless of whether the increase over the numbers in the incoming outside air is large or small. If the increase is large, measures should be taken on the inside to reduce the numbers, either by supplying a larger quantity of outside air or by eliminating dirty conditions within. If the incoming air is unclean it should be subjected to some cleansing process, or else the source of supply should be changed.

The above investigation was made in the Laboratory of Sanitary Engineering of Harvard University under the general direction of Professor George C. Whipple, and was made possible by funds kindly furnished by Mr. Ernest C. Dane of Brookline.

Through an oversight, a note was omitted in the August issue that the paper by C. C. Wilcox on "A Pressure Survey Study Constituting a Report on the Comparative Use of Exhaust and Live Steam for Heating" was presented at the recent annual convention of the National District Heating Association, in Chicago.

TABLE III.—SUMMARY OF ANALYSES OF AIR. SAMPLES TAKEN IN CARS OF BOSTON ELEVATED RY. CO. HARVARD SQUARE—PLEASANT STREET LINE.

Bacteria.

Section of route.	Bacteria per cu. ft. Gel. at 20°C.	Bacteria per cu. ft. Agar at 38°C.	Number of passengers.
March 17, 1914.*			
Harvard Square to East Cambridge	57	43	7 to 35
Scollay Square to Pleasant St. and return	133	57	30
East Cambridge to Harvard Square	103	43	5 to 25
East Cambridge to Scollay Square	197	193	12 to 26
Park Street to East Cambridge	213	187	17 to 50
Outside air, Pierce Hall	33	17	....
April 1, 1914.†			
Harvard Square to East Cambridge	566	67	9 to 45
Pleasant Street to North Station	1,500	1,080	7 to 33
North Station to Pleasant Street and return.	4,660	3,330	4 to 26
Outside air, Pierce Hall	117	10	....

Dust Particles.

Section of route.	Dust particles per cu. ft.	Number of passengers.
March 17, 1914.*		
East Cambridge to Scollay Square	388,000	35 to 67
Haymarket Equare to East Cambridge	1,105,000	25 to 30
Harvard Square to East Cambridge	274,000	5 to 19
Scollay Square to Pleasant Street	1,809,000	4 to 26
East Cambridge to Memorial Hall	947,000	20 to 40
Outside air, Pierce Hall	133,000	....
April 1, 1914.†		
Viaduct to Pleasant Street	1,425,000	7 to 54
Viaduct to Inman Square	3,415,000	19 to 30
East Cambridge to North Station	1,027,000	26 to 27
Outside air, Pierce Hall	122,000	....

*The streets on this day were damp from rain that had fallen a few hours previously.
†The streets on this day were dusty, following two days of dry weather and brisk winds.

TABLE IV.—SHOWING NUMBER OF DUST PARTICLES IN OUTSIDE AIR ON DIFFERENT DAYS. HARVARD UNIVERSITY, CAMBRIDGE, MASS.

Dust particles per cu. ft. at Pierce Hall.*	Date.	8 a. m. Wind.	8 a. m. Weather.	4 p. m. Wind.	4 p. m. Weather.	Remarks.
	Apr. 2			Light E.	Clear to rain	Streets wet. Snow at night
	Apr. 3	Light W.	Cold Clearing	Brisk N. W.	Fair	Freezing during night
280,000	Apr. 4	Fresh N. W.	Cold Fair	Fresh W.	Fair	Streets dusty after noon
116,000	Apr. 5	Light S. W.	Cold Cloudy	Fresh S. W.	Clearing	Light rain up to noon
177,000	Apr. 6	Light W.	Cold Fair	Light S. W.	Fair	Streets somewhat dusty
158,000	Apr. 7	Brisk N. E.	Cold Rain	Light N. W.	Cloudy	Streets verv muddy
226,000	Apr. 8	V. Light N. W.	Cold Foggy	Light S. E.	Mist	Streets muddy all day
91,000	Apr. 9	Fresh N. W.	Mild Clearing	Brisk N. W.	Partly cloudy	Streets became partially dried
113,000	Apr. 10	Brisk W.	Cold Fair	Fresh S. W.	Fair	Streets dusty
366,000	Apr. 11	Brisk S. to High	Mild Fair	High S.	Fair	Verv dusty day Light rain in night
139,000	Apr. 12	Brisk S. W.	Mild Fair	High N. W.	Fair	Not much dust until noon. Gale late in P. M.
121,000	Apr. 13	Brisk N.	Cold Fair	Fresh N. W.	Fair	
109,000	Apr. 14	Fresh S. W.	Cold Fair	Light S. W.	Fair	

*Composite samples taken at different hours of the day.

Three Methods of Measuring Radiant Heat From Gas Fires

Much interest was aroused at the last meeting of the heating engineers' society by the description given by George S. Barrows of a method for determining the amount of radiant heat given off by gas radiators. This description, published in The Heating and Ventilating Magazine for May, 1915, is now supplemented by an account of the way radiant heat from gas fires is measured in England, as given by W. R. Twigg in Domestic Engineering (London).

WATER FLOW RADIOMETERS USED.

The first method is by the use of the water flow radiometer, as it is termed, designed by J. G. Clark, of the technical staff of the Gas Light & Coke Co. This apparatus is shown in Fig. 1 and consists of a copper tube of rectangular section, 2 in. x ⅛ in. inside dimensions. The tube is 54 in. long. One surface is blackened and used to absorb radiation, while the other surfaces are polished to reduce radiation. The tube is suspended on a suitable stand in such a way that heat cannot readily travel from one to the other by conduction. Water is caused to enter the tube at the bottom and to pass away at the top through a funnel switch. Thermometers graduated to 1/10° C. are provided at the top and bottom waterways to indicate the temperature of inlet and outlet water streams. The whole is mounted upon a quadrant base. This quadrant is reversible and can be used on either side of the fire under test, thus forming a complete semi-circle around the center of the fire. Holes are provided in this quadrant 10° apart, corresponding with pegs in the tripod foot of the stand, thus enabling the apparatus to be quickly and accurately placed in various positions around the fire, so that the blackened sur-

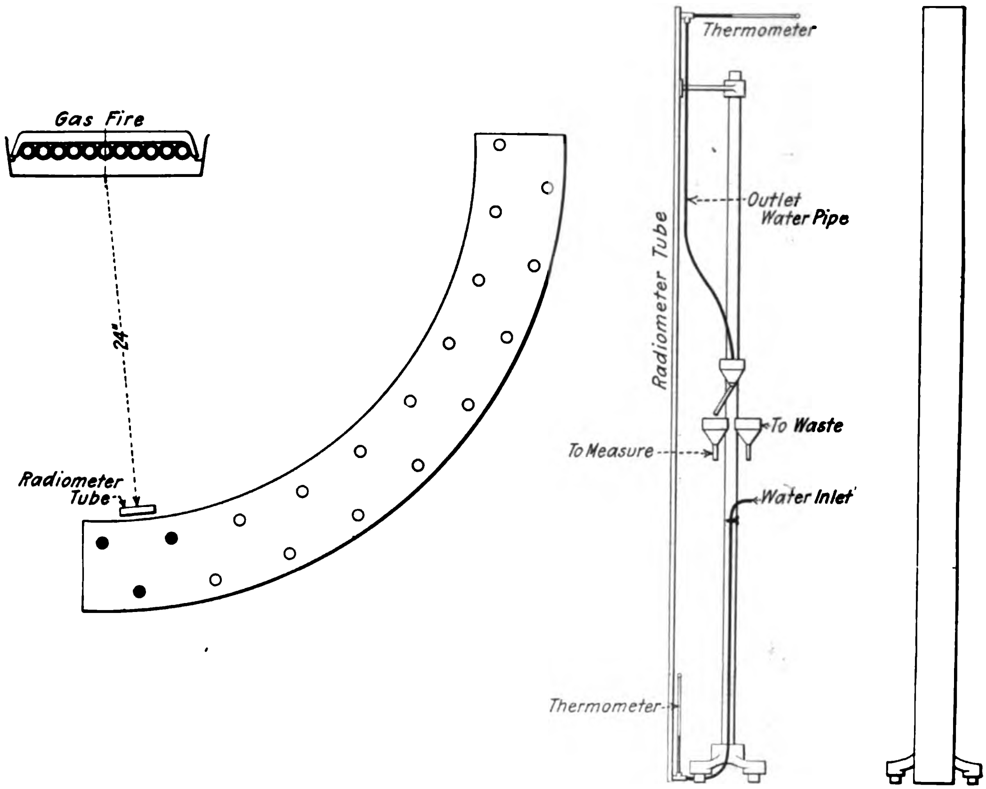


FIG. 1—WATER FLOW RADIOMETER, DESIGNED BY J. G. CLARK, FOR MEASURING RADIANT HEAT FROM GAS FIRES.

face is normal to a line drawn from its center to the center of the semi-circle.

It is apparent that if a semi-cylinder of 24-in. radius and 54 in. long be cut into a number of vertical strips, each will to some extent represent a surface similar to that provided by Mr. Clark's radiometer. Mr. Clark did not try to take the total radiation incident upon a hemisphere in front of the fire under test, being of the opinion that this does not represent the actual value of the fire from the point of view of the user.

Mr. Clark places both the fire and the radiometer on the floor level, and fills in the semi-circle of 24 in. radius in front of the fire with glazed tiles which reflect a considerable proportion of the heat known as downward radiation. Also Mr. Clark purposely neglects any rays projected above the semi-cylinder, as these are directed to the ceiling, and are of little, if any, value in practical heating.

METHOD OF TESTING WITH THE CLARK INSTRUMENT.

In making a test, the instrument is first placed in position centrally in front of the fire to be tested, and a current of water caused to flow at such a rate that its temperature is raised from 4° to 5° C. in passing through the tube; when the inlet and outlet temperatures are steady, the thermometer readings are observed and the rate of water flow is determined by experiment. A polished copper screen is then placed about 2 in. in front of the tube, and between it and the fire tested, thus shielding the blackened surface from radiation from the fire; temperature readings are again taken, the rise in temperature is again noted and deducted from the rise previously observed, giving a net rise due to absorption of radiation from the fire, from which, with the known rate of water flow, the rate of absorption can be quickly calculated.

These observations are repeated at va-

rious points around the fire, and from the mean value so obtained and the relative areas of the radiometer tube, the total radiation incident upon the cylinder is calculated, this relationship being as follows: (a) surface of radiometer 2 in. x

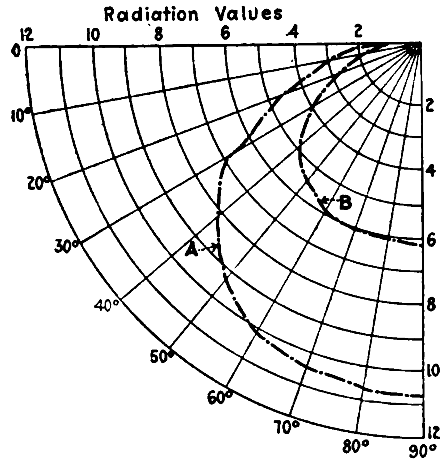


FIG. 2—DIAGRAM SHOWING SEPARATE VALUES OBTAINED FROM THE CLARK RADIOMETER IN VARIOUS POSITIONS.

54 in. = 108 sq. in.; (b) surface of semi-cylinder, 24 in. × 3.1416 × 54 = 4,072 sq. in.

$$\text{Ratio} = \frac{b}{a} = 37.7$$

Therefore, the mean value given by the radiometer in heat units per hour x 37.7 = total radiation per hour.

The separate values obtained from the radiometer in various positions may be plotted in the form of a polar diagram. Fig. 2 shows two curves so plotted, one from radiometer values, the other from thermopile readings.

THE GLOVER WATER FLOW RADIOMETER.

The next method of determining radiator efficiency is also a water flow radiometer used for direct absorption. In this case the apparatus is designed to absorb the total radiation incident upon a hemisphere in one operation. It consists of a hemispherical body made from two copper hemispheres, having diameters of 18 in. and 18½ in., respectively. Each hemisphere has a turned-over flange, by means of which the two are bolted together and supported. Suitable guides are placed in the small water spaces left between the two hemispheres to cause water that enters at the bottom of the apparatus to flow evenly over the whole surface before leaving by the outlet at the top. The whole is suitably mounted and the reverse sides are lagged and protected from radiation, etc. Fig. 3 illustrates the apparatus in which point 1 is the point at which cold water is admitted, a thermometer at 2 indicating its temperature, 3 being a hemispherical heat-absorbing surface. The heated water passes out at 4, its temperature being

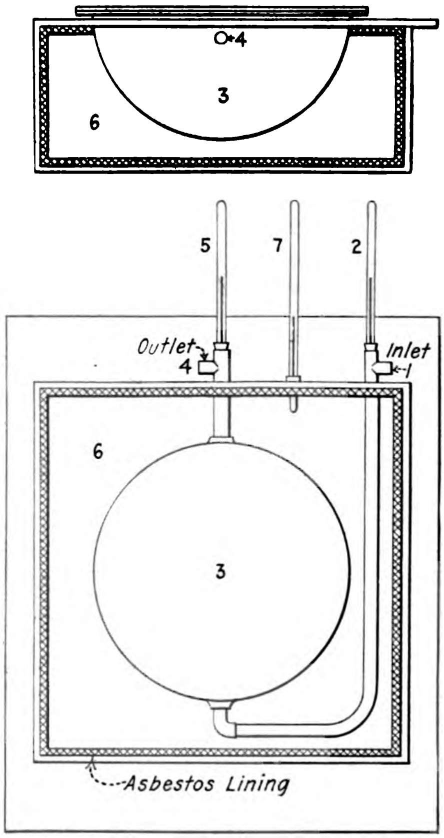


FIG. 3—GLOVER WATER FLOW RADIOMETER.

indicated by a thermometer 5. A dead air space enclosed suitably is provided at 6, the temperature of which is indicated by thermometer 7.

The manipulation of this apparatus will be clear from the particulars given for other methods. For correcting the rating readings of this instrument to the

equivalents of the Research Committee of the Institution (British) of Gas Engineers, Mr. Glover found that a correcting factor of from 1.28 to 1.32 was required, and finally the average figure of 1.3 was adopted.

THIRD SYSTEM UNDER DEVELOPMENT.

The third system for determining radiant efficiencies is now being developed in the laboratories of the Davis Co., at Luton, England. This apparatus is also of the water flow radiometer type.

In this method a water-cooled segment is used, but instead of taking separate readings at various positions, the segment is caused to slowly rotate round its vertical axes. A special duplex meter is used controlling both the supply of gas to the fire and water to the radiometer, a definite quantity of water passing with every cubic foot of gas, means being provided for adjusting the water flow to compensate for variations in temperature and pressure at which the gas is measured. In such an arrangement the difference in temperature of the water entering and leaving the radiometer may be expressed either in degrees of heat or directly in heat units per cubic foot of gas passed by meter. This latter graduation is used, but thermometers are provided for purposes of checking. Fig. 3 is an illustration of the partly developed apparatus. A delicate thermocouple having two hot and two cold junctions is used, the cold junctions being in the inlet water stream, the hot junctions in the outlet water stream, and a current is therefore set up, its intensity depending upon the difference in temperature of the two streams of water. The thermo-couple is connected to a delicate reflecting galvanometer, graduated directly into heat units per cubic foot of gas used, the whole being so arranged that a photographic

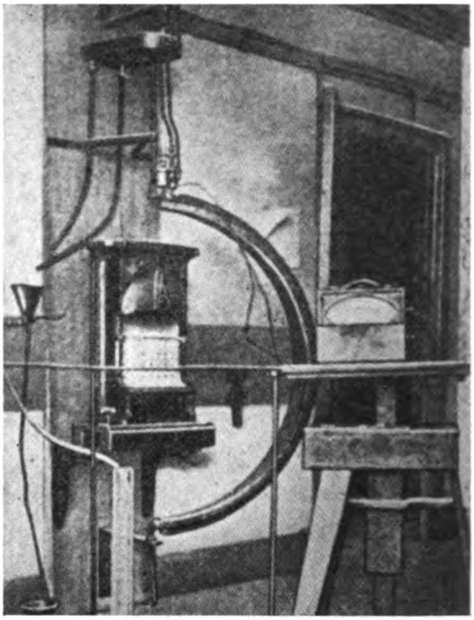


FIG. 4—NEW TYPE OF WATER FLOW RADIOMETER BEING DEVELOPED BY THE DAVIS COMPANY.

record of the galvanometic indications is taken in the form of a polar diagram showing the distribution of radiation around the fire in heat units per cubic foot of gas. From this the total radiation and efficiency is easily calculated. It is proposed to take check readings with the segment rotating about a horizontal axis which will also give a further knowledge of the distribution. So far as can be stated at present, a correcting factor of 1.2 will be required with the instrument, but it is hoped to be able to introduce a permanent compensation in the meter that will give results directly comparable with the results obtained by the methods of the Gas Heating Research Committee of the Institution of Gas Engineers.

Radiator Traps and Test Data

By L. M. Arkley, M. Sc.,

Lecturer in Mechanical Engineering, University of Toronto.

In order to test the comparative efficiencies of several well-known makes of radiator traps, a series of experiments were conducted recently at the University of Toronto, the results of which are reported in *The Sanitary Engineer* of Toronto:

The testing apparatus consists essentially of a standard type of radiator having 60 sq. ft. of radiating surface and which is connected to the steam pipes in the same way as when set up for actual service. A mercury manometer is attached to the inlet pipe to register the pressure of the steam entering the radiator, while a thermometer in the same pipe can be used to indicate the temperature when desired. To the outlet pipe is attached a radiator trap E, a tank B, in which is collected the condensed steam from the radiator, a glass condensing coil, and a glass jar A, which condenses and collects any steam that may pass the trap.

There is an advantage in having the condensing coil and jar A of glass, as, during the test, the rate at which the steam is passing the trap may be noted and the completeness of condensation verified.

The desired vacuum was indicated on gauge C, and was obtained by connecting the apparatus to a vacuum pump as shown.

The object of test was to determine:

(a) Whether the traps performed their main function, namely, that of allowing all water of condensation to pass from the radiator without letting steam pass as well.

(b) The temperature efficiency of radiator.

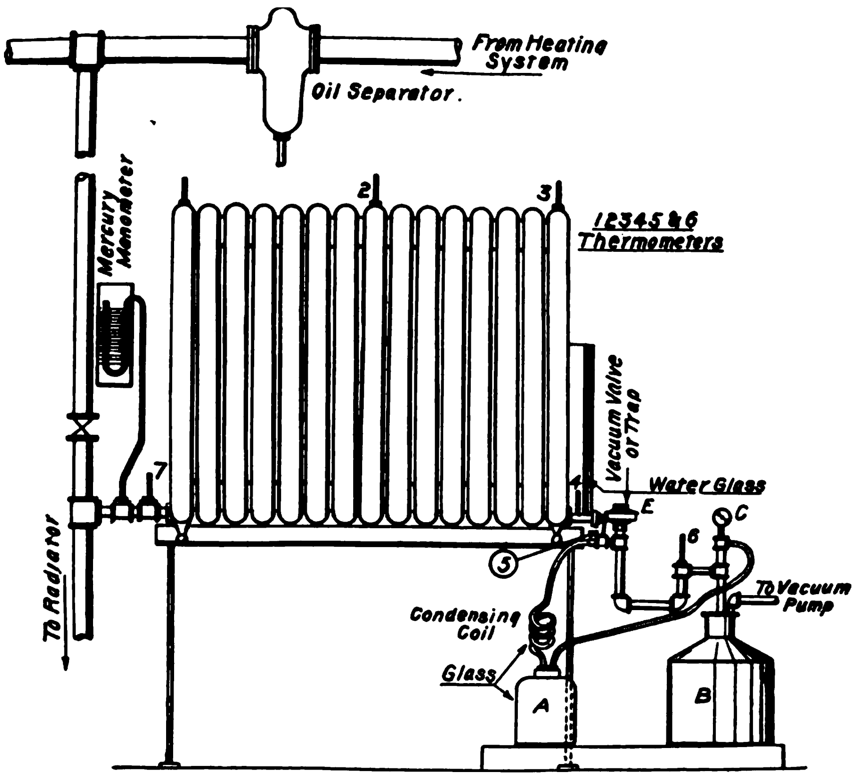


FIG. 2—ARRANGEMENT OF APPARATUS FOR TESTING RADIATOR TRAPS.

(c) Whether all air was removed from the radiator by the trap.

(d) Whether the traps performed their functions without noise.

METHOD OF MAKING TESTS.

Before starting the tests, steam was turned on the radiator and the system allowed to heat up to its normal working condition; after this, readings of temperatures and pressures were taken at intervals of ten minutes for a period of two hours. If any water had collected in the radiator during the test it was drawn off and weighed.

By referring to Fig. 2, it will be seen that tanks A and B are so connected that they are always under the same vacuum or pressure, the water-leg preventing steam from passing to the tank B. Therefore, if any steam passes the trap, it will find its way to the condensing coil and from there to the tank A. The weight of water in B represents the steam condensed in the radiator, while the water in A, after the proper corrections has been made, represents the steam that has passed the trap.

METHOD OF COMPUTING RESULTS.

In order to get the true value of the steam passing the trap, a correction must be made to the quantity caught in tank A, because a certain amount of the water in the radiator, which would remain as water while under the pressure in radiator, would burst into steam after passing to the lower pressure beyond the trap. The following method will give a close approximation to what this correction should be:

Let A = the number of pounds of water caught in tank A.

Let B = the number of pounds of water caught in tank B.

Let r = the heat of vaporization of one pound of saturated steam under vacuum.

Let X = temperature of water at thermometer No. 4.

Let Y = temperature of steam corresponding to vacuum.

Let C = correction, i. e., the number of pounds of water to be deducted from A.

Let E = net weight of steam passing trap.

LOG SHEET OF DATA—FOR TESTS 2 TO 9.

No. of test.	Values given.	Time.	Pressure ins. of mercury.	Vacuum ins.	Temperatures, Deg. F. 1	2	3	4	5	6	Room.	Name and type of trap.	Aver. temp. of radiator, deg. F.	Temp. efficiency of radiator, per cent.	Steam condensed in radiator, lbs.	Steam passed by trap, lbs.	Steam passed by trap, per cent.
2	Min.	10:11	2.7	9.0	214.0	215.0	213.0	212.0	182.0	180.0	100.0	*Webster	....	....	....	....	....
	Max.	to	3.8	9.0	216.0	217.0	215.5	215.0	191.0	187.0	106.0	Sylphon	....	....	....	....	....
	Aver.	12:11	3.05	9.0	215.0	215.6	214.4	213.8	188.5	185.0	102.0	Trap	215.0	99.1	38.5	0.00	....
4	Min.	10:40	2.7	9.0	214.0	215.0	214.5	215.0	183.0	190.0	....	*D. G. C.	....	....	....	....	....
	Max.	to	3.1	10.5	215.0	216.0	215.0	216.0	194.0	198.0	....	Disc	....	....	....	....	....
	Aver.	12:40	2.92	9.6	214.6	215.5	215.0	215.7	190.6	194.0	....	Trap	215.0	99.2	43.5	0.54	1.22
5	Min.	20:8	2.7	10.0	213.5	214.5	214.0	214.5	189.0	192.0	98.0	*"Vento"	....	....	....	....	....
	Max.	to	3.3	10.0	215.0	215.0	215.0	215.0	190.0	193.0	110.0	Thermostatic	....	....	....	....	....
	Aver.	40:8	2.96	10.0	214.0	215.0	214.2	215.2	189.7	192.4	107.0	Trap	214.4	98.94	46.5	0.58	1.21
6	Min.	15:5	2.1	9.0	213.0	214.0	213.0	212.0	186.0	182.0	106.0	*"Welo"	....	....	....	....	....
	Max.	to	4.2	10.0	217.0	217.5	217.0	215.0	189.0	183.0	107.0	Low pressure	....	....	....	....	....
	Aver.	3:55	3.03	9.16	214.7	215.4	214.6	212.5	188.5	182.0	106.7	Trap	214.9	99.1	36.0	0.00	....
7	Min.	10:29	4.5	8.0	217.0	218.0	216.0	207.0	172.0	173.0	95.0	*"Sarco"	....	....	....	....	....
	Max.	to	4.6	10.0	217.5	218.25	217.0	217.25	194.0	197.0	101.0	*......	....	....	....	....	....
	Aver.	12:29	4.54	9.32	217.3	218.10	216.9	214.5	181.0	180.2	99.0	......	217.4	99.2	41.0	0.25	0.6
8	Min.	2.25	3.1	7.5	215.0	215.0	214.5	215.0	191.0	183.0	97.0	Marsh	....	....	....	....	....
	Max.	to	5.6	9.5	219.0	220.0	219.0	219.0	192.0	188.0	104.0	*Reflex	....	....	....	....	....
	Aver.	4:25	5.08	9.1	218.1	219.1	218.2	217.5	191.8	186.0	101.4	......	218.5	99.3	39.5	0.03	....
9	Min.	10:12	3.9	9.0	217.5	217.0	215.6	216.0	180.0	176.0	75.0	*Dunham	....	....	....	....	....
	Max.	[illegible]	4.0	10.5	217.5	217.0	216.0	216.0	184.0	190.0	79.0	No. 1 Radiator	....	....	....	....	....
	Aver.	[illegible]	4.0	10.0	217.5	217.0	215.8	216.0	182.0	187.5	76.0	Trap	216.8	99.2	39.1	0.00	....

LOG SHEET OF COMPLETE DATA TAKEN IN LEADING TEST, NO. 1

Time, P. M.	Steam pressure, ins. of mercury.	Vacuum, ins.	Temperatures in Degrees F. 1	2	3	4	5	6
2:48								
2:50	2.2	10.0	214.0	214.5	214.0	214.0	187.0	190.0
3:00	2.2	10.0	214.0	214.5	214.0	214.0	189.0	192.0
3:10	2.2	10.0	214.0	214.5	214.0	214.5	190.0	192.0
3:20	2.1	10.0	213.5	214.5	214.0	215.0	191.0	193.0
3:30	2.1	9.5	213.5	214.5	214.0	214.5	190.0	192.0
3:40	2.1	10.0	213.5	214.5	214.0	214.5	191.0	193.0
3:55	2.1	10.0	213.5	214.5	214.0	214.0	189.0	191.0
4:05	2.1	10.0	214.0	214.5	214.0	214.5	190.0	191.5
4:15	2.4	10.0	214.5	215.0	214.0	215.0	190.0	192.0
4:25	2.5	10.0	214.0	215.0	214.5	215.0	190.0	193.0
4:35	2.5	10.0	214.0	215.0	214.5	215.0	190.5	193.0
4:45	2.5	9.5	214.0	215.0	214.5	215.0	191.0	193.0
4:48	2.5	10.0	214.0	215.0	214.5	215.0	191.0	193.0
Average values	2.27	9.9	213.9	214.6	214.1	214.6	190.0	192.0

Total period of test.. = 2 hrs.
Average temperature of radiator.................................. = 214.2° F.
Temperature corresponding to pressure in radiator.......... = 215.6° F.
Temperature efficiency of radiator............................ = 99.3%
Name of trap .... Webster water seal motor.
Steam condensed in radiator.................................. = 38.5 lbs.
Steam passed by trap.. = 0.61 lbs. = 1.58%
No air or water collected in radiator.
Operation of trap noiseless.

$$\text{Then } C = \frac{X - Y}{r} \times B \text{ and } E = A - C.$$

The above correction, while not exact, is quite close enough for practical purposes, and as it has been applied to each valve tested, the comparison should be fair.

The temperature efficiency of the radiator is defined as the average temperature of the radiator divided by the temperature of saturated steam corresponding to the pressure in the radiator. The temperature efficiency gives a very good indication of the quantity of air being trapped and held in the radiator sections. For instance, if the temperatures as read from thermometers 1, 2 and 3, Fig. 2, are nearly equal, and not far below that corresponding to the steam pressure, it shows that steam is filling each section and therefore air must be absent. In the following tabulation the first test is given complete; in the others, only the minimum, maximum and average values are given for the pressures and temperatures, and the final results.

PURPOSE OF TESTS.

These tests were made primarily for the purpose of satisfying the writer as to the value of radiator traps which he has had occasion to specify at different times in connection with the design of low pressure heating systems. Numerous inquiries along this line from architects and heating engineers would indicate that the question is a live one.

It must be remembered that there are other important features connected with radiator traps which cannot be decided by laboratory tests, for example, mechanical construction, on which depends the life of the valve and its seat. The lift of the valve from its seat and the shape of both valve and seat determine its likelihood to clog on account of scale or dirt coming from the radiator. The ease with which the traps may be cleaned and kept in running order is also a very important feature. Mechanical knowledge and good judgment on the part of the purchaser should enable him to choose the best trap from a mechanical standpoint, but the length of life and other such questions can only be determined by comparing the action of traps operating over long periods of time under similar conditions.

The writer wishes to acknowledge suggestions and help given by Professor R. W. Angus, of the Department of Mechanical Engineering of the University of Toronto, and also the hearty co-operation of the manufacturers who furnished the traps tested.

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THE importance to the heating trade of watching the course of pending legislation in the various State legislatures does not, ordinarily, appeal to the average heating man, but in the light of the information brought out at the recent convention of the master steam fitters' association, it is evident that a very real danger exists in the passing of drastic and ill-considered laws relating especially to the operation of heating plants. It was brought out, for instance, that a large mass of this sort of legislation was introduced during the past winter and one of the principal reasons given for its failure to pass was the fact that most of the legislatures were congested with bills. In a few cases the activities of the different associations were effective in rooting out "jokers" and "strike legislation," but in most of the cases cited the trade appeared to be entirely unaware of the dangers that lay before it.

One of the commonest types of bills coming under this heading were those providing for State inspection of steam boilers, where provision is made for State boards of inspection and requiring boilers to be inspected periodically and a fee to be paid. It is well understood that such a law is intended to apply to power boilers, but where the pressures carried are not mentioned, the passage of such bills, as was tersely stated, "would mean a large decrease in steam and hot water heating jobs in favor of furnace work, especially in the smaller jobs."

One of the most pernicious types of bill is that which provides that all operators of steam boilers over a certain size, and frequently the exemption is very small, must not only be examined by a State board, but must be licensed by a State board to operate a boiler. A number of instances were found where the wording of the bill would require every flat or apartment house which uses steam heat to employ a licensed engineer or fireman to run its boilers.

Still another class of legislation would empower a State board, and in Pennsylvania, for instance, a local board in each city, to pass arbitrarily upon the safety of each installation before the plant could be accepted and placed in use.

It will also be a matter of information to many to know that where there is no State law on the subject a municipality can regulate these things in the same way as it provides smoke ordinances and similar restrictions.

Fortunately, there is little likelihood of further objectionable legislation until 1917, as most of the legislatures have adjourned until that time, but it is predicted that unless preventive measures are taken in the meantime the trade "can depend upon it that sooner or later every legislature in this country is going to have something to say about boilers and inspection and about insurance."

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

51—Data on Overhead Steam Heating.

QUESTION: Can you inform us where we may get a book of plans or other information treating on one and two-pipe overhead steam heating plants? What we want is a book covering this system in detail so that we can arrange our piping correctly on a system carrying about 3,500 sq. ft. of radiation using exhaust steam.

ANSWER: A description of the Mills sys-

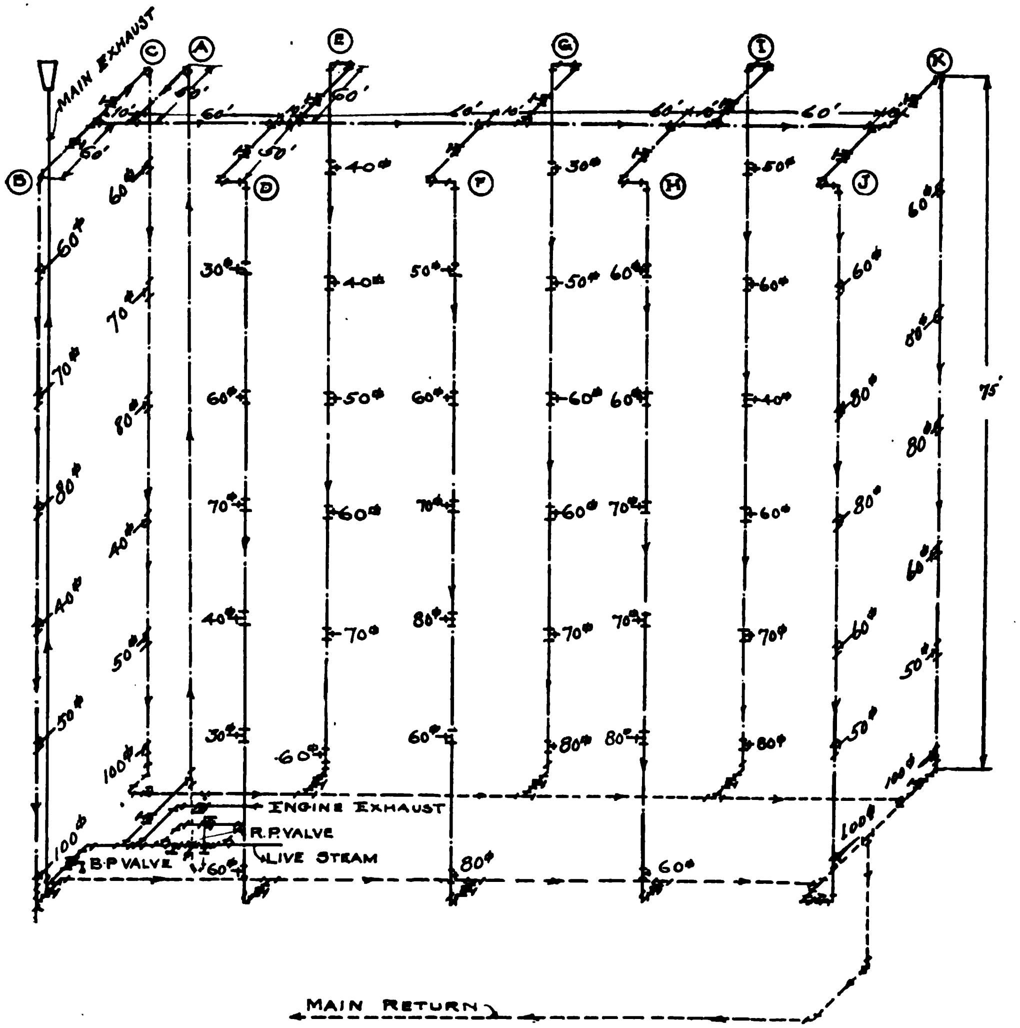


FIG. 1—SKETCH SHOWING ARRANGEMENT OF MILLS SYSTEM OF HEATING.

tem can be found in Mills' book on heating. Although this book is out of print, it may be had in many of the public libraries The Mills system is merely an overhead system, with single pipe riser drops. One of the best publications on pipe sizes is a pamphlet published by the Positive Differential System Company, of New York. By using the table contained in this pamphlet, giving the pounds steam for each size of pipe per 100 ft. of length for every drop in pressure in ounces, all that is necessary is to figure the pounds of steam required at each branch and take from the table the size pipe for the distance and discharge, marking the drop in pressure from one connection to another. When the trial sizes are completed, the size pipe may be adjusted so that for each required discharge at each outlet there shall be the same drop in pressure from the source.

Fig. 1 is an isometric sketch of what is known as a Mills system of piping. The figures give the lengths of piping and Table 1 will be used for determining sizes.

This table was compiled by J. A. Donnelly and the writer has changed the square feet of radiation to pounds steam per hour as radiation is used under such varying conditions that if the rates are reduced to pounds of steam per hour, the table becomes universal for all systems and conditions under which radiation operates. For higher pressures the pipe sizes would be too large.

Assuming a maximum pressure of 5 lbs., the radiation will give off

$(220 - 70) \times 1.7 = 255$ B.T.U. per sq. ft.

Allow 20% for radiation and initial heating up, and the condensation will be 0.3 lbs. per square foot of surface. As the piping is laid out so that every radiator is the same distance from the source or supply and return point of the system, the risers should have practically the same drop in pressure.

Each riser is 75 ft. long and assuming one-half the length and lengths of runout, we will assume lengths as follows for the total radiation on each.

Risers C, E, G, I, K will be 100 ft. long.

Risers B, D, F, H, J will be 110 ft. long.

TABULATION OF SIZES OF RISERS AND DROP IN PRESSURE.

Riser.	Surface, sq. ft.	Lbs. steam per hr.	Length, ft.	Drop, oz., 2-in.	Drop, oz., 1½-in.
B	400	120	110	2.11	11
C	400	120	100	1.92	10
D	290	89	110	1.18	6
E	380	114	100	1.9	9.6
F	400	120	110	2.11	11
G	350	105	100	1.7	8
H	340	102	110	1.9	9
I	360	108	100	1.7	8.5
J	430	129	110	2.11	11.8
K	430	129	100	2	10.8
A	3,780	1,136	200	....	....

Drop in Pressure in Mains.

	Lbs. steam per hr.	Diam. pipe, ins.	Drop, oz.	Diam. pipe, ins.	Drop, oz.
K to I (70 ft.), supplying risers J and K	258	2½	1.9	3	0.7
I to G (70 ft.), supplying risers H, I, J, K	468	3	2.14	3½	0.93
G to E (70 ft.), supplying risers F, G, H, I, J, K	693	3½	2.24	4	1.05
E to A (70 ft.), supplying risers D, E, F, G, H, I, J, K	896	4	1.6	4	1.6
Total drop in supply mains			7.88		17.10
A (200 ft.)	1,136	4	7.9	5	2.16
Riser with max. drop (J)	5	1½	11.8	2	2.11
Return same as main supply	...	...	7.88	...	8.55
Total pressure drop			35.46		17.10

Note: Pressures and drops were interpolated in some cases.

The small sizes will give a drop of 2.22 lbs. and large ones 1.1 lbs.

Risers A and C will not be included as the drop will be less than the others. The sizes, however, will be A to B, C (10 ft.), 240 lbs. steam per hour, 2-in. pipe, 0.77 oz. drop.

DISCHARGE OF STEAM MAINS IN POUNDS OF STEAM PER HOUR

SHOWING DROP IN PRESSURE IN OUNCES PER 100 FT. RUN: NOMINAL SIZES PIPE USED.

MEAN PRESSURE 2 LBS. GUAGE

VELOCITY FT. PER SEC	10 FEET		20 FEET		30 FEET		40 FEET		50 FEET		60 FEET	
SIZE MAIN	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.
1- INCH	.40	7.5	1.6	14.7	3.6	22.2	6.4	30.	10.	37.2	14.4	44.4
1-1/4 "	.29	11.7	1.16	23.1	2.61	34.8	4.64	46.5	7.25	58.2	8.28	68.6
1 1/2 "	.2	16.8	.8	33.6	1.8	50.4	3.2	67.2	5.	84	7.2	100.8
2 "			.48	60.	1.08	80.	1.92	120.	3.	150.	4.32	180.
2 1/2 "					.75	139.5	1.34	186.	2.1	232.5	3.02	279
3 "					.56	200.7	1.00	267.6	1.56	334.5	2.25	4014
3 1/2 "							.85	364.8	1.33	456.	1.8	547.2
4 "							.66	480.	1.04	600.	1.5	720
5 "							.48	744	.75	930.	1.08	1116.
6 "									.57	1341	.82	1609.2
8 "											.56	2862
10 "												
12 "												
14 "												
16 "												

VELOCITY FT. PER SEC	70 FEET		80 FEET		90 FEET		100 FEET		110 FEET		120 FEET		130 FEET	
SIZE MAIN	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.	DROP OZ.	STEAM PER HOUR LBS.
1- INCH	19.6	52.2	25.6	59.4	32.4	67.2	40	74.4						
1-1/4 "	11.4	81.3	14.72	93.	23.5	105.	29	116.4						
1 1/2 "	8.8	117.6	12.8	1344	16.2	151.2	20.	168.						
2 "	5.88	210.	7.68	240.	9.6	270.	12.	300.						
2 1/2 "	4.1	325.5	6.37	372	6.8	418.5	8.4	465.						
3 "	3.06	468.3	4.00	535.2	5.06	602.1	6.25	669.						
3 1/2 "	2.6	6384	3.4	7296	4.3	820.8	5.31	912.						
4 "	2.04	840.	2.66	960.	3.37	1080.	4.16	1200.						
5 "	1.37	1302.	1.92	1488.	2.43	1704	3.0	1860.						
6 "	1.12	18774	1.47	21456	1.86	2413.8	2.3	2682.						
8 "	.66	3339.	1.00	3816	1.26	4293.	1.56	4770.	1.89	5262	2.25	5724		
10 "		5208.	.75	5852.	.95	6696.	1.18	7440.	1.43	8184	1.7	8928	2.	9672
12 "			.60	8592	.76	9666.	.94	10740	1.14	11814	1.36	12888	1.70	13962
14 "					.63	13149	.78	14610	.95	16071	1.13	17532	1.32	18993
16 "					.53	17172	.66	19080	.80	20988	.95	22896	1.2	24804

50—Figuring Tank Sizes.

QUESTION: I am often asked the question regarding tank sizes; that is, what size tank would be required for a certain number of fixtures. I have failed to find any information of this kind in books and am taking the liberty of asking you if you have any information on this matter or can tell me where I can get the information. How much hot water is ordinarily used for a bath? How much for a lavatory, etc.?

ANSWER: There are no set rules for this. A 30-gal. tank is generally considered sufficient for five people; that is, one bath and two basins. In large buildings a shower generally requires 6 gal., a bath 10 gal. and a wash basin 1 gal. When they are set in batteries the frequency of their use is taken into account, which is governed by circumstances in each individual case.

Where showers are in a battery and are used altogether, the number of baths should be multiplied by 6 gal. and, if there is a long interval between times of use, the storage tank can be made so as to take care of the sudden draft and the heater made of only sufficient capacity as to furnish the hot water over a longer period by continuous operation.

Suppose we had 10 showers and 60 men would have to use them at a certain hour in the day. This would require 360 gal. of hot water in perhaps the course of one hour. As the tank heater could run 10 hrs. to heat this water, a 400-gal. tank could be used and a heater installed only large enough to heat 40 or 50 gal. per hour.

Instantaneous heaters are frequently used for such service, but they require a large amount of power over a short interval of time and are only practicable where power in large quantities is available.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

FUTURE DEVELOPMENT—

Some Future Developments in Heating and Ventilation. A. H. Barker. Problems of this science. 6,500 w. Archt., Lond.—May 21, 1915. 40c.

GAS HEATING—

Cost and Method of House Heating by Gas. F. R. Hutchinson. Ills. 3,000 w. Gas Age—June 1, 1915. 20c.

OZONE—

Ozone—An Aid to Factory Ventilation. V. D. Greene. How foul air and offensive odors can be cheaply overcome. 4,000 w. Engng. Mag.—July, 1915. 40c.

Air Permeability of Building Materials.

As the result of tests made by the laboratory of technical physics of the Technical High School at Munich and reported by Hans Freiherr von Thielmann in Gesundheits-Ingenieur, coefficients have been developed for the permeability of certain building materials which have been placed on the market in recent years, notably chalky sandstones. In an abstract of this article published in the Journal of the American Society of Mechanical Engineers for August, 1915, the arrangement of the testing apparatus is shown and described. The test consisted briefly in exerting an air pressure of about 100 mm. of water on one side of the material and measuring the air that passed through.

The material investigated was of various thicknesses, on the average 60 mm. The part of the stone facing the outside atmosphere had often to be limited to 10 by 10 cm. because with a larger area of outflow the air velocities in the meter and drying flask were too high, which created undesirable disturbances, such as the carrying over of particles of calcium chloride, used to keep moisture away from the material, into the piping. The duration of the test was on the average 30 minutes and the air temperature about 20° C.

Each test was, as a rule, repeated three times and the data reported represent an average of all three tests. The Lang law was sometimes used in the calculations; viz., that the volume of air flowing through is inversely proportional to the thickness of the material.

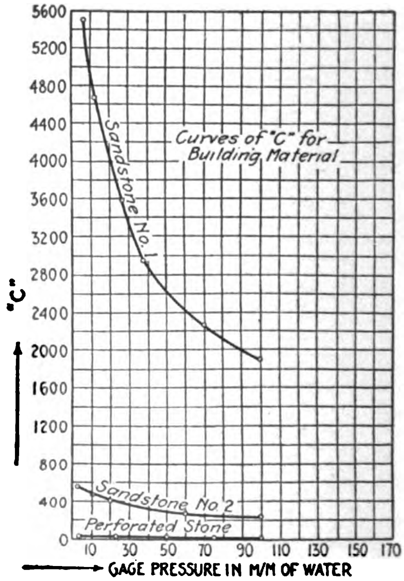
The values obtained are shown in the second column of the accompanying table. From them is calculated the coefficient of permeability c, under the assumption that the volume of air Q flowing in a unit of time through an area F of stone is inversely proportional to its thickness d, and directly proportional to the gage pressure p. Under this assumption the volume of air flowing through the stone is defined by the equation

$$Q = c\,p\,F$$

and c indicates therefore the volume which will flow per hour through 1 sq. m. of stone surface, 1 m. thick, at a gage pressure of 1 mm. of water (the table, because of lack of space, is given in an abbreviated form). The "perforated stones" were bricks having four cylindrical perforations of 4 cm. in diameter, running parallel to their long edge, 12 cm. long. In addition to tests at the constant gage pressure of 100 mm., a series of tests was also made at variable pressures, data of which are given in the original article in a table. From these data, the coefficient of air permeability c was calculated and is shown in the accompanying curves. As has already been noticed by Gosebruch, c is not constant but increases as the pressure decreases, this increase being considerably greater with goods of porous material than with tougher materials. The decrease of air permeability with an increase of the pressure differences is to be explained by the fact that the rapid growth of frictional resistance at greater pressure

DATA OF TESTS ON AIR PERMEABILITY OF BUILDING MATERIALS.

Material	Q – 1 per hr.	c (average value)
Sandstone	5,680,000	
	3,715,500	
	3,136,500	997
Chalky sandstone.......	76,060	
	39,170	
	29,060	14.4
	4,890	
	4,760	
	2,670	1.23
Perforated brick........	36,640	
	32,720	
	7,474	
	4,547	5.83
Hand-made brick (hard burned)	7,540	2.26
Machine-made brick....	8,346	
	6,820	
	1,915	
	1,880	1.42



CURVES SHOWING AIR PERMEABILITY OF THREE BUILDING MATERIALS.

differences, and hence increased velocity of flow, produces a strong reduction of the motion of air through the material in the case of materials with very large pores. There is, in addition to that, the influence of flow produced by the phenomenon of expansion and turbulent motion in the hollows which affects still more the air permeability of the material at higher pressures.

An Architect on Modern Ventilation Ideas.

Some idea of what the architect thinks of the trend of thought in recent years regarding the art of heating and ventilating is given in an address by Charles Sumner Kaiser, of San Francisco, before the American School Hygiene Association. His comments display a close observation of recent developments in this connection:

After a full generation of our respected but obsolete heating and ventilating standard, we have come at last to see that the chief physiological purpose of ventilation is not merely to provide air to breathe, but to aerate the whole body and aid its nicely balanced heat mechanism in maintaining the constant temperature upon which life depends. We have found that the precise and overheated product of our "standard" heating plant tends precisely against this vital purpose, while the environment that promotes it is the moving, changing, relatively humid open air. Upon this better realization are based three interesting and divergent lines of progress—in mechanical ventilation, in the application of the "fresh air" idea and, finally, in the approach to a higher and truer ideal in heating science.

Our older system has had its own line of development, in air-washing, moistening and regulating apparatus, chiefly, and is now facing almost a revolution. Hygienists of reputation have asserted that the purity, temperature, humidity and movement of the air can be fully controlled by such mechanical means, and hence that health-giving conditions for schools can be most efficiently realized by closing the outdoor supply, sealing the windows, and mechanically rewashing, recirculating and using practically the same air over and over again. Such a system has been installed in the new Wethersfield Avenue School, Hartford, capable of operating with only 10% of outdoor air. If this method is a success, mechanical ventilation will indeed have reached its logical, if somewhat startling, conclusion.

At the farthest extreme from this is the happy and beneficent "Open Air School," with its direct recourse to nature. Here temperature is secondary so long as the air is fresh, while the heat economy of the body is promoted in all climates by suitable clothing, feeding and physical activities. There is every reason for the wide favor this school is gaining. It seems to offer the only effective invitation to that vague wholesome outdoor quality which still eludes capture at the hands of ventilating engineers, and which is still missed in the compromises frequently attempted.

Each of these methods, in its own way, looks back to nature. Neither, however, quite achieves her high ideal, for a complete "natural standard" of warmth and air has not been adequately formulated. The air of nature is most vitalizing and agreeable, not merely when cool and moving, but when heat energy is streaming through it on the rays of the sun. As with an open fire, this radiance brings physical comfort with air temperatures, 8° to 12° lower than where heat is carried by the air itself, with marked effects in physical and mental stimulation. Nature's method, accordingly, gives the body adequate heat without depriving it of really fresh air. At the same time it exhibits that complete separation of heating and ventilating functions which is so much desired and theorized about, but which is almost never found in practice.

It is precisely in the unnatural combination of these two functions, in fact, that all our troubles arise. Our unsanitary dust-decomposing "radiators," so called, are designed chiefly to heat the air by convection and circulation. Unless this air itself is overheated enough to counterbalance the heat losses through the walls and windows of rooms, such surfaces will remain cold and must absorb heat from the occupants, inducing chill. This is aggravated by the relative dryness of the overheated air and the consequent rapid evaporation of the surface moisture of the body. For both comfort and health, therefore, the natural principle seems to be that heat should not be carried primarily by the air, but should be imparted in some measure to the building itself. Our ideal, in other words, demands that the radiant heat of the sun shall be brought indoors.

POSSIBILITIES OF RADIANT HEAT.

Though the idea is far from new, the possibilities of radiant heat have hardly been touched in modern times. Undoubtedly the most splendid examples of radiant heating were the Calidaria of the ancient Roman baths, in which the hot gases from fires were carried under the floors and upward through hollow walls. The same method seems to have been used in some Roman palaces for comfort alone. After the lapse of centuries, however, this same principle has reappeared on a large scale

in the "Hot Panel" system of heating, originally devised by A. H. Barker, B.Sc., of the University College, London, and applied by Captain H. Riall Sankey, R.E., in some important buildings at Liverpool—in particular, the Royal Liver office buildings and the Midland Adelphi Hotel. Here the heat radiating elements have taken the form of hot wall panels, floor borders, cornices, and even the ceilings of rooms; and the results are said to have exceeded all expectations. The plane radiating surfaces are proved to be much more effective than ordinary "radiators"; their temperature is kept relatively low; the lower air temperature permitted requires less fuel to produce and involves less waste by radiation through unheated walls and windows.

While these installations were probably expensive, the fundamental idea is simple, and it can and doubtless will be simply applied as soon as the subject is better understood. John V. Van Pelt's suggestion of foot-warming plates for open air schools is a step in this direction. Cheap electric current would here offer the most attractive possibilities. When fully developed, radiant heating should not only prove invaluable for schools, but it is the one kind of heating that is perfectly adapted to hospitals and sanitoriums.

In view of this advance in heating science, the pursuit of a natural, healthful ideal by the means now employed seems quite futile. For this purpose nature must be more closely studied, and our artificial methods profoundly modified. Measured by the same ideal, the open air school itself accepts a too stern and cheerless natural standard—fresh air without the full pervading warmth of sunshine. This, however, may be incidental, for the spread of this splendid type of school is doubtless far less retarded by the indifference to the fresh air ideal than by the prevailing sedentary character of school work; all of which leads to the conclusion that a natural ideal of warmth and air must involve likewise more natural and suitable school occupations.

New York School of Heating and Ventilation.

The class in heating and ventilation, conducted by Charles A. Fuller under the name of the New York School of Heating and Ventilation, will open for the fall season in Room 511, World Building, New York, the first week in October. Sessions will be held thereafter weekly on Monday evenings at 7:30 P. M. The secretary of the school is George G. Schmidt, 132 Nassau Street, New York.

The Electric Fan as an Adjunct to the Heating System.

The ordinary electric fan can be effectively used to increase the efficiency of the heating system of a building in cold weather. In connection with steam heating a fan placed upon the floor in such a position that it blows the cool air against the radiator will materially increase the heat convection from the radiating surfaces. Placed in the cold-air intake of a hot-air furnace it will not only cause the rooms to heat more quickly, but will increase the efficiency of the furnace and improve the ventilation of the building.

A series of tests were conducted by two senior students of the University of Missouri to ascertain the saving in coal effected by the use of the electric fan as above described. The building tested was an eight-room frame dwelling, approximating in design, construction and arrangement the average American home, and while the figures obtained apply only to the house tested, nevertheless, they will furnish an approximate guide to the possible saving in homes by the use of a fan.

In the tests, the amount of coal necessary to maintain the house at a uniform temperature of 71° F. for various outdoor temperatures was determined both with and without the fan. The method of firing, the rate of stoking and the setting of the dampers were the same for all the tests. The coal used was a hand-picked, Illinois lump coal, with an average heating value of 13,500 B. T. U. per pound. The interval between stokings was arbitrarily chosen as 15 minutes. Readings were taken of the amount of coal fired, outdoor temperature, temperature in cold-air duct, velocity of air in cold-air duct, temperature of air leaving registers, room temperatures, watts input to the fan and line voltage.

Each test was begun with the average house temperature in the neighborhood of 71° F. Readings were taken every fifteen minutes until the average house temperature had remained constant for at least an hour. If this average temperature was above 71° F., the amount of coal fired every fifteen minutes was reduced, and if below 71° the amount of coal fired was increased. Thus the proper amount of coal required to maintain the average house temperature at 71° was determined for various outdoor temperatures with and without the fan running.

From data tabulated from a test made with an outside temperature of 15° F., it was observed that, although the outdoor temperature had increased 1° in the second

part of the test with the fan shut off, the furnace required 8 oz. more coal every fifteen minutes to maintain an average room temperature of 71.3°. The tests were repeated for outdoor temperatures of 4°, 25° and 35° F., with the results shown in the table.

RESULTS OF TESTS AT VARIOUS TEMPERATURES.

Outdoor Temp'ture, Deg. F.	Lbs. of Coal Fired Every 15 Mins. With Fan.	Without Fan.	Lbs. of Coal Saved in a Day of 16 Hrs. by Using Fan.
4	6.0	6.5	32
15	4.0	4.5	32
25	2.5	3.0	32
35	2.0	2.25	16

With coal at $4 per ton, the amount saved per day in the cost of coal was 6.4 cts. With electricity at 6 cts. per kw.-hr., the cost per day of running the fan, which consumed 47 watts, was 4.6 cts. The net saving obtained by using an electric fan in the cold-air duct of a furnace was, therefore, 1.8 cts. per day at the above prices for coal and electricity.—Percy W. Gumaer, in the *Electrical World,* abstracted by *Engineering Digest.*

Suggestions for Installing and Testing Factory Exhaust Systems.

Further details of the operation of the Illinois blower law, contained in the recent report of the Illinois chief state factory inspector, Oscar F. Nelson, state that the work connected with the so-called dusty trades, such as employment around metal polishing, buffing and grinding machinery, was considered so hazardous an occupation that life insurance companies used to refuse to accept as risks the men engaged in the above mentioned trades. The introduction of properly designed and effectively operated exhaust systems in connection with the wheels and belts, thereby removing the dust and allowing the men to work in a pure atmosphere, has so far corrected the danger of disease as to make these men acceptable insurance risks in most companies.

Referring again to the construction of hoods that cover the wheels, a little clearer idea is given in the words of the report, which states that "one of the greatest mistakes in the construction of exhaust systems arises in the construction of hoods that cover the wheels. It seems to be a habit to install hoods with the branch pipe connecting to said hood in the rear of the wheels at a distance of from 18 to 24 in. from the point of work on the wheels. This manner of constructing hoods is unfair and dangerous to the workman and unfair to the firm for whom the plant is being installed, for the reason that on the first visit of the factory inspector these hoods are ordered replaced by those of a more efficient construction. This entails a far greater expense than would have been incurred had the proper hoods been installed in the beginning. This department is ordering all hoods of an improper construction replaced by those that have the branch pipe connected to the hood directly beneath the part of the wheel that comes in contact with the work, and as near to the point of work on the wheel as the character of the work will permit. The department also advises and urges that an additional suction be provided in the rear of the wheel near the center, in order that the light floating dust that missed the front suction may be picked up and carried away. Where such an additional suction is used, care must be taken to design the two openings so that their combined area equals the area of the branch pipes into which they open. This light floating dust constitutes the dangerous element."

It is also stated that hoods must be of a substantial character so as to act as efficient guards for the wheels. Many accidents happen to workmen by pieces of work catching in the wheels and revolving with them. This often happens on buffing wheels, where employees' hands are sometimes badly mangled.

Another point in the construction of exhaust systems is to eliminate as many bends and elbows as possible. The dust collector should be installed as near the fan as possible, and the fan as near the wheel as possible. All branch pipes on blower systems where over three machines are connected should be equipped with blast gates for the purpose of equalizing the suction power, so that the pipes farthest away from the fan will get the required suction.

"A great fault," declares the report, "of several of the constructors of exhaust systems is an attempt by them to convince the manufacturer that the 5-in. suction power in the U-shaped tube, as required by the Illinois law, is not necessary. The department knows from practical experience that it is necessary and will insist upon that part of the law being complied with. The 5-in. suction is necessary so that the blast will extend far enough from the opening of the branch pipe to entirely cover the zone of the wheel, thereby removing the floating dust."

METHODS OF TESTING EXHAUST SYSTEMS.

Three methods of testing exhaust systems are contained in the report. The apparatus necessary for such a test is very simple, consisting only of a U-shaped tube and short pieces of rubber and metal tubing. The rubber tubing allows for the proper placing of the U tube, because in all testing the U tube must be exactly perpendicular. The short length of metal tubing attached to the end of the rubber pipe provides for perfectly stable conditions as regards the placing of the apparatus for a test which will record the nearest possible status to actual working conditions.

The first method is to tap the branch pipe with a center punch and insert the end of the pipe leading to the U-shaped tube. Care must be taken to punch the hole at least 6 in. from any elbow. This method is liable to error, because as a rule the air velocity recorded is that velocity near the edge of the pipe, which is less than the velocity near the center due to friction of the air blast with the sides of the pipe.

The second method is to insert a stationery tube, centrally located as regards the branch pipe to be tested, about 8 to 10 in. in the opening of the pipe.

The third method, which should only be used on systems of three or more machines, is to remove the hood and after making a small hole about one-eighth of an inch in diameter in the cardboard, to place the cardboard over the opening of the branch pipe and make the test at the hole in the card. Care must be taken to have the small test hole as near the center as possible, and to have all other branch pipes open at the time of the test. Of the three methods, the second one should be used, according to the department, whenever possible, as it is the most accurate, because it comes nearest to representing the actual conditions and requirements of practical work, and is least liable to error.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Arrangements for Semi-Annual Meeting.

Headquarters for the forthcoming meeting of the American Society of Heating and Ventilating Engineers, which will be held in Atlantic City, Thursday and Friday, September 16 and 17, will be at the Marlborough-Blenheim Hotel. The first session is called for Thursday afternoon. A second session will be held the same evening. The third and last session will be held Friday afternoon. This leaves both mornings free.

Following the close of the meeting on Friday, there will be a dinner and dance at the Marlborough-Blenheim.

In addition to the papers and reports announced last month, there will be reports from the society's chapters and also a report from the committee to co-operate with the National Fire Protection Association.

Plans for the Annual Meeting.

According to a circular sent out by Secretary J. J. Blackmore, the American Society of Heating and Ventilating Engineers, at its next annual meeting, will devote one day to the subject of the cost of operating heating and ventilating plants. To assist the various committees that will collect the data, a set of questions has been prepared and sent out to the membership for the purpose of obtaining all the knowledge and experience possible relating to the subject. Data on two or more buildings are desired, if possible, and the cost of operation should extend over two seasons, to see how much variation there is in such costs. The investigation will cover schools, hospitals, public buildings, churches, office buildings, apartment buildings, stores, theatres, factories and residences. Committees to be appointed later will classify and correlate these data.

NATIONAL DISTRICT HEATING ASSOCIATION

Plans for Future Development.

The registration at the recent convention of the National District Heating Association reached high water mark, there being 260 in attendance, representing 72 district heating plants. These figures are given in a circular letter sent out by President David S. Boyden, who states that plans for making the association of still greater value and benefit are under way, including the following:

To ask each member to procure at least one additional member, either Class A. B. C or associate, during the coming year.

To establish in the early fall a Quarterly Bulletin, to be sent to every heating company in the United States and Canada and which will afford a means of exchange of ideas and experiences available to all engaged in the industry.

To encourage the standing committees to carry on and enlarge their work which has been so successful during the past two years.

To enlarge the scope of the work of the association in order to make it of the greatest value to the members and encourage the construction of district heating systems.

CORRESPONDENCE

Heat Emission from Radiators.

Editor HEATING AND VENTILATING MAGAZINE:

The articles on "Heat Emission from Radiators," which have appeared in your March and August issues, have prompted the writer to submit a table which he has used successfully for a number of years, and which varies from the one given by C. D. Allan.

The writer has found that a higher value may be given to the coefficient "K" than Mr. Fuller gives. Nelson S. Thompson, in his "Mechanical Equipment for Federal Buildings," uses a value of 1.8 for three-column, 38 in. high radiation.

The following table is based on observations made of actual operating conditions in temperatures to 10° F. below zero, and altitudes up to 5,000 ft. It is assumed that the air moves over the heating surfaces at a speed of 3 ft. per second for heights above 20 in. and that the velocity diminishes as the height of the radiator is lessened.

TABLE OF HEAT EMISSION IN B.T.U. PER SQUARE FOOT OF CAST IRON RADIATION AT 150° F. DIFFERENCE BETWEEN STEAM AND AIR. SEA LEVEL CONDITIONS; RADIATOR LOCATED UNDER WINDOW.

Type of radiator.	Height of radiators in inches 38	32	26	22	20	18	16	14
One-column	285	290	295	300	298	295	292	290
Two-column	270	275	280	290	287	285	282	280
Three-column	250	255	260	270	268	266	263	260
Four-column	230	235	240	250	248	245	242	240
Flue, narrow	260	270	280	285	...	...	...	...
Flue, window	...	...	...	...	290	287	285	283
Wall, bars vertical	...	310	...	...	...	...	...	...
Wall, bars horizontal	...	...	...	...	...	...	...	300
Wall, flat at floor		(as in dry room)			420	...	...	...
Wall, flat at ceiling		(as in factory)			280	...	...	...

The above is based on 70° F. inside, zero outside, at sea level. Wind velocity, 15 miles per hour, average for year.

Add 2% for every 500 ft. in altitude.

Add 1% for every mile increase in wind velocity.

Add 5% where radiator is located on inside wall near window.

Add 10% where radiator is located between windows.

Add 10% where radiator is located on inside wall opposite windows; use flue type radiators, if possible.

It will be noticed that the above figures would produce a very uneven curve. The writer has used multiples of five for ease in calculation; also the value of "K" is more conservative than Mr. Thompson uses, owing to difference in the class of buildings. EDWARD D. BOTTSFORD.

Newark, N. J., August, 1915.

New Circular on Bomb Calorimeters.

A circular describing the methods of calibrating and using bomb calorimeters, for determining the amount of heat available in a given weight of coal, coke or other fuel, has recently been issued by the United States Bureau of Standards. As the available heat in any one kind of fuel depends largely upon its quality, it has become the practice, where fuel is purchased in large quantities, to determine the heat available per pound and from that determine the price of the fuel, usually described as purchase on "the B.T.U. basis."

The bomb calorimeter consists essentially of a steel shell in which a small, weighted sample of the fuel can be burned in pure oxygen gas. The bomb is immersed in a known amount of water before the sample is ignited. The heat produced warms the water and the difference in temperature of the heated water determines the amount of heat given off by the fuel.

In order to standardize the bomb calorimeter, use is made of standard samples of certain pure materials, such as sugar, naphthalene and benzoic acid. By burning known amounts of these substances in the bomb, the observer may determine the amount of heat required to raise the temperature of the bomb, together with the proper amount of water, one degree. This being determined, the amount of heat fur-

nished by a given sample of coal burned in the same bomb, with the same amount of water, is readily found. By the use of these samples, which are furnished by the Bureau of Standards, it is possible to obtain correct results from tests made anywhere.

Panama-Pacific International Exposition.

5—KEUFFEL & ESSER COMPANY.

Three Grand Prizes have been awarded to the Keuffel & Esser Co., Hoboken, N. J., at the Panama-Pacific International Exposition, for their exhibits of drawing materials and slide rules, surveying instruments and telescopic sights and periscopes. Unusual interest centers in the exhibit of this company as it furnished many of the engineering instruments used in the construction of the Panama Canal.

The exhibit comprises practically every requirement of the engineer for field or office work. The variety of devices ranges from the small hand instruments used for the roughest preliminary survey to a triangulation theodolite, reading angles to single seconds, and a photo-theodolite, representing the finest types of precision instrument construction. Among the improved and time and labor-saving devices shown are the K. & E. stadia circle, a device simplifying to the last degree the reduction of stadia measurements and obviating the necessity of using the charts, tables and slide rules now familiar to the engineer.

The slide rules shown include many new types. The chemist's duplex slide rule is especially adapted to the solution of problems in stoichiometry, such as gravimetric and volumetric analysis, equivalents, percentage composition, conversion factors and many other problems familiar to the chemist.

The Allen friction head slide rule simplifies the calculations connected with the installation of steam heating, hot water heating and steam power piping.

The surveyor's slide rule reduces the calculation of azimuth meridian and stadia reductions and other hitherto complicated calculations to mere mechanical operations and enables the engineer in the field to compile these data using the ordinary engineer's transit fitted with vertical circle.

The Roylance electrical slide rule gives a single setting for any standard size copper wire, the diameter in mils, area in circular mils, area in square inches, weight in pounds per 1,000 ft. of bare wire, resistance in ohms per 1,000 ft. at any degree centigrade and the carrying capacity of different kinds of wires and cables.

The K. & E. power computing slide rule solves the equation, Plan/33,000 equals H.P., and computes the power and dimensions of steam, gas and oil engines.

The merchant's slide rule is especially designed to meet the needs of the merchant and solves in a simple manner such calculations as discounts, simple and compound interest, prorating, converting feet into meters, pounds into kilograms, taking off a series of discounts, adding profits to cost, etc. In fact, almost all problems which are of everyday occurrence in the office or workshop can be solved without mental strain and at a remarkable saving in time.

A complete line of drafting room furniture, such as tables, chests, blueprinting frames and machines, drawing boards and drawing tools is attractively displayed.

To complete the exhibit, a testing laboratory has been installed wherein are demonstrated all of those tests which are

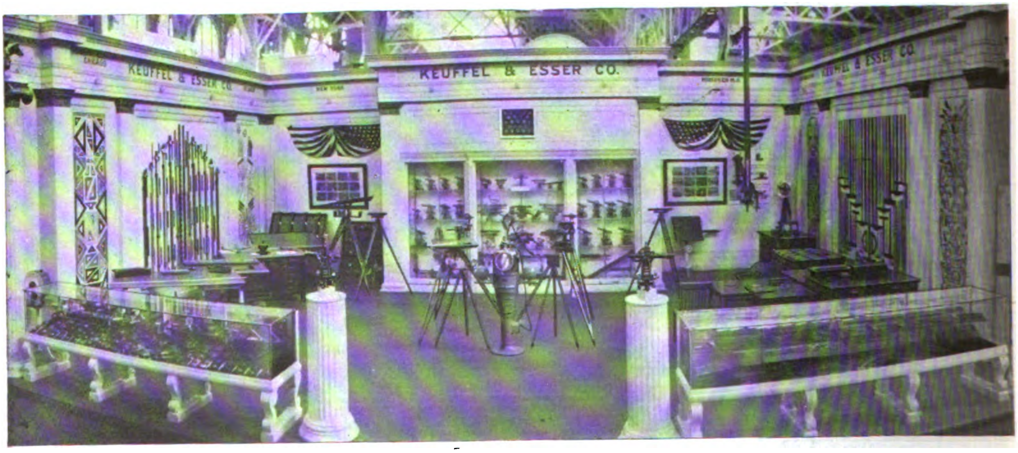


EXHIBIT OF KEUFFEL & ESSER AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION.

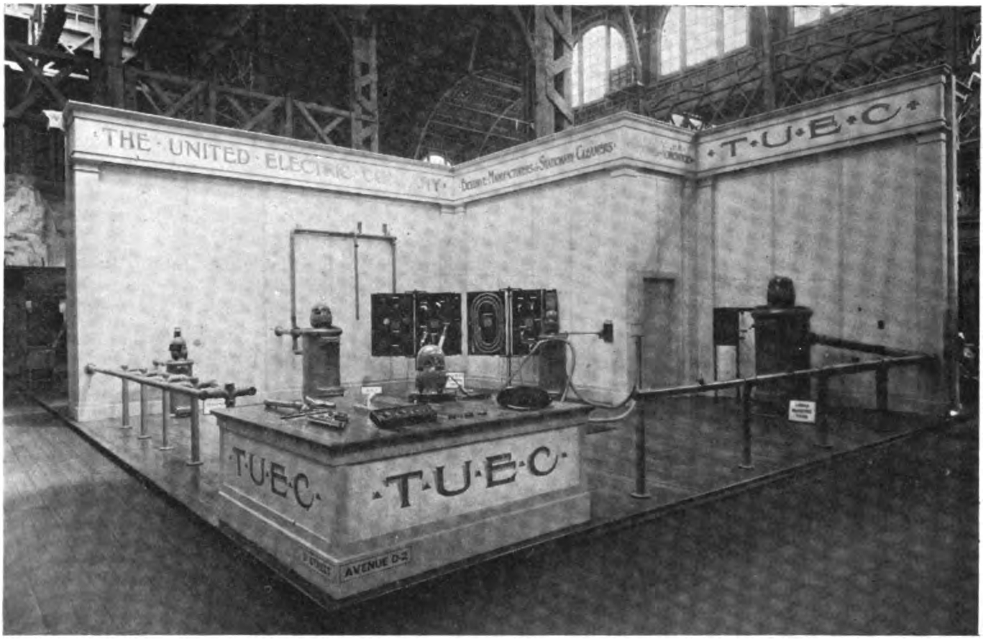


EXHIBIT OF THE UNITED ELECTRIC COMPANY AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION.

necessary to insure the quality and accuracy of all K. & E. products.

6—THE UNITED ELECTRIC COMPANY.

The entire line of Tuec stationary cleaners, manufactured by the United Electric Company, Canton, O., are shown in the exhibit of this company at the Panama-Pacific International Exposition. Four machines are set up on the floor, all connected and illustrating the various methods of installation. Every tool manufactured by the company is also included in the display, as well as every kind of hose. In addition to the regular sections of hose, 6-in. lengths of each are on exhibition showing the cross sections.

A complete line of the different inlet valves, in all finishes, are shown, together with a full set of inlet shanks in the different lengths. These shanks are coppered, and nickeled, but not polished, and present a most unusual appearance. All of the 2½-in. fittings are arranged in that part of the booth where the inlets and tools are shown.

A rotor, fan, etc., is placed in a prominent place where they can be examined easily, and a case, lined with green felt, contains four different size S. K. F. bearings. This, in itself, attracts considerable attention, as it brings out the quality of the only two wearing surfaces in the Tuec. The rail around the booth is a novelty and is made up of Tuec pipe and fittings, bearing out the color scheme in vogue through out the booth.

The exhibit is located in the Varied Industries Building, and is in charge of Jerry Snyder, manager of the company's Toronto factory.

NEW DEVICES

New Gas-Steam Radiator.

Something new in the way of a gas-steam radiator has recently been brought out by the Garwood Gas Lamp & Heater Co., Canton, O., and is shown herewith. This apparatus, it is stated, is the result of more than eight years of exhaustive experimenting. The radiator, it will be noticed, is a heating unit in itself, having no water connection. Four or five quarts of water are poured in the water-filling plug once every four or five months.

The radiator consists of a series of plain design radiator sections, an automatic thermostatic valve and a gas burner. It is claimed that this is the first heating appliance of its kind which will not permit the products of combustion to escape to the room heated. This is due to the new unitary heating and combustion chamber

which consists of a series of ribs on the middle sections of the radiator which dovetail together when the sections are assembled. This construction affords a completely enclosed combustion chamber, there being no openings except the small air ports at the bottom which provide for the secondary air supply for the flame.

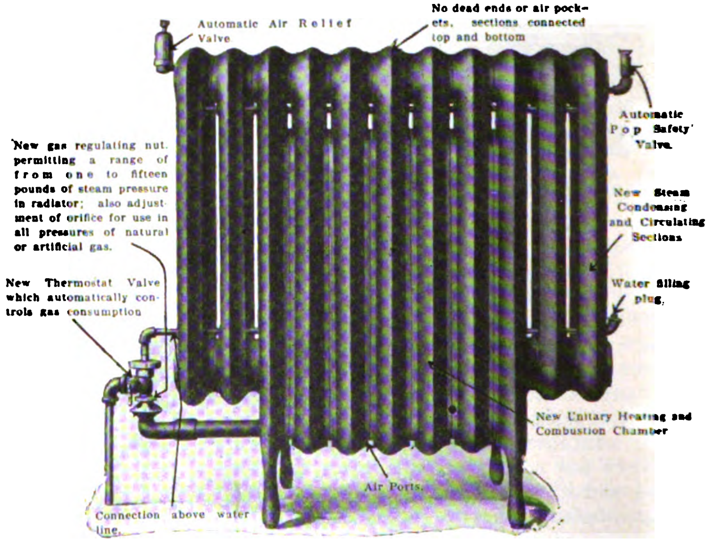
A new circulating method is obtained by the use of overhanging loops which are placed at each end of the radiator. These loops do not come over the gas burner, so that a different temperature exists in the overhanging loops than in the center loops which are directly over the burner. As all sections are connected at the top, this arrangement provides that the steam as generated will rise and flow into the overhanging loops where it condenses and runs down to the bottom of these loops. The water then finds its level back over the heat of the burner.

In a test of a 10-section radiator which is reported by the manufacturers, using 4 qts. of water and plugging the return opening from the overhanging loops, less than 5 hrs. were required before all of the water was in the four overhanging loops. At the end of these 5 hrs. the six middle loops were dry.

Although the new gas regulating nut in the radiator permits a range of from 1 to 15 lbs. of steam pressure in the radiator, this nut is set to 5 lbs. pressure. As soon as the gas is lighted, steam begins to be generated in the radiator. As the steam pressure increases, the gas consumption decreases, and, after 5 lbs. pressure has been reached, only enough gas is consumed to maintain these 5 lbs. of steam pressure.

This radiator is made in two distinctive styles. In addition to the type described, another style is made without the combustion chamber. This type is for use especially in sections of the country where artificial gas is burned. The object of the heating and combustion chamber, with flue connection, is to carry away all fumes and condensation, but with artificial gas, it is stated, this is usually unnecessary.

In regard to gas consumption, a test was made on one radiator of eleven 26-in. sections, 3-column, containing about 42 sq. ft. of radiation. This radiator required 18 cu. ft. of gas per hour to raise 5 lbs. of steam pressure with 3 qts. of water, this being accomplished in 17 min. After this steam pressure was reached, the thermostatic valve automatically cut down the gas consumption to less than 8 cu. ft. per hour, at which point the 5 lbs. of steam pressure was maintained in the radiator for 72 hrs.



NEW TYPE OF GAS STEAM RADIATOR.

Trade Literature.

Savo Air Moistener, intended for use on any steam or hot water radiator to supply any desired amount of moisture in a room, is an interesting product of the Savo Mfg. Co., Chicago, Ill. The device is described and illustrated in a circular recently issued by this company. One of the features of the Savo air moistener is its compactness which permits it to be placed at the back of the radiator out of sight. It is made in three styles, Style No. 1 being 14 in. high and 12½ in. wide; Style No. 2 is 14 in. high and 8 in. wide; Style No. 3, 9 in. high and 12½ in. wide, and Style No. 4, 9 in. high and 5 in. wide. Still another style is made for use in connection with warm air furnaces, supplanting the water pan in the furnace. This style, No. 5, is adjusted to fit in any floor register box where the diameter of the hot air pipe is from 8 to 12 in. The company's standard size moisteners are made to fit radiators which measure 2½ in. from the outside of one coil to the outside point of the next coil, but the company makes Nos. 1 and 3 styles to fit radi-

ators of different construction. Emphasis is properly laid on the point that one moistener should not be expected to humidify an entire house. A number of facsimile letters are included expressing the satisfaction of users in residences, offices, piano warerooms, schools and hospitals. Numerous authorities are

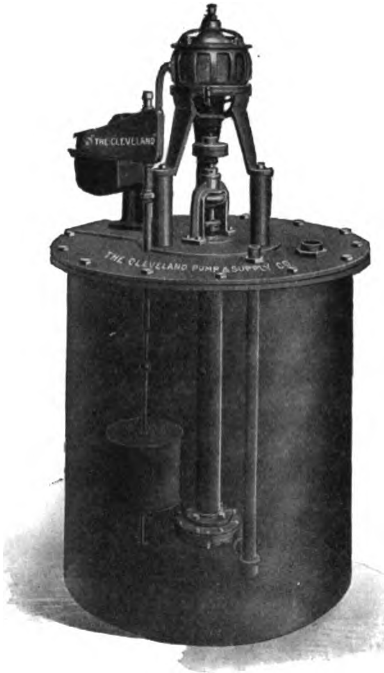
SAVO AIR MOISTENER.

quoted on the disastrous effects of dry indoor air and the advantages of proper indoor humidity.

Cleveland Automatic Condensation Pump and Receiver is the subject of a timely circular describing this apparatus which serves to return the condensation from a heating system to the boiler automatically. The motor

FILLING SAVO AIR MOISTENER WITH WATER.

and automatic control are mounted on the receiver cover and when the receiver is placed below the floor level it requires little space. Ten points of superiority possessed by the Cleveland are given, as (1) automatic and dependable; (2) requires no unusual attention; (3) automatic oiling arrangement; (4) complete, compact, simple and efficient; (5) all steam jackets packed; (6) motor placed at highest point above water—impossible to flood or splash; (7) float may be removed without disturbing other parts; (8) weight and thrust of pump carried by ball thrust bearings, independent of motor; (9) pump and motor shafts connected through flexible coupling; (10) pump and switch rods provided with stuffing boxes. All sizes are designed for 15 lbs. boiler pressure. The apparatus is made by the Cleveland Pump & Supply Co., Cleveland, O., also manufacturers of automatic electric sump pumps, cellar drains and sewage ejectors.



CLEVELAND AUTOMATIC CONDENSATION PUMP AND RECEIVER.

Powell Boiler Valves, illustrating the complete line of boiler room valves, including the White Star valve, made by the Wm. Powell Company, Cincinnati, O., are the subject of a new booklet. From this line, it is stated, suitable valves may be selected for installation in any industrial plant in the country. The company adds that it is prepared at all times to furnish Monel metal valves at special prices. The general description given of the construction of the Powell line leaves no doubt of the quality of this product, as well as the care used in its manufacture. The valves especially featured in the catalogue include the Powell patent "Cyclone" blow-off valve, extra heavy iron body straightway "Y" blow-off valve, the new Powell "Irenew" valve, the Powell "White Star" boiler gate valves and "Model Star" gate valve, the new Powell "White Star"

double automatic boiler check valve and the Powell automatic injector. The company also makes a complete line of boiler and engine room trimmings.

HUGHSON STEAM SPECIALTIES, now sold by the Illinois Engineering Company, Chicago, Ill., succeeding the Hughson Steam Specialty Company, are called to the attention of the trade in a catalogue devoted to the Eclipse line. This line includes regulating, blow off, automatic stop and check valves and separators made of semi-steel, or of steel and with bronze, nickel bronze, Monel metal or nickel steel trimmings. This line was formerly made by the John Davis Company. Size 6 x 9 in. Pp. 40.

DETROIT'S INDUSTRIAL PLANTS are shown on a post card folder, containing 22 views, 12 of which are those of the world's largest manufacturers in their respective lines. One of those shown is the plant of the American Blower Company.

Winner Boiler Compound.

Winner boiler compound, described as an eradicator and sure preventive of scale formation in boilers, is an interesting product of The Winner Co., 71 Morton Street, New York. This compound is equally adaptable to marine and stationary boilers and excellent results are reported in a number of Coast line vessels in which the compound is regularly used. The manufacturers emphasize the point that Winner boiler compound contains no element that will damage piston rings or packing, and that it is effective in removing and preventing scale from magnesia, iron, sulphur, sulphate of lime, carbonate of lime, phosphate of lime or any mineral matter held in solution. The company gives interesting figures regarding the increase of fuel necessary to produce a certain steam pressure through a coating of scale. For 1/16 in. of scale, the fuel increase is given as 10 per cent.; for ¼ in. scale, the fuel increase is 40 per cent. One gallon of the Winner compound is recommended to 1,000 H.P. every 24 hours as sufficient to produce satisfactory results. The company is represented in New York by Joseph H. Sloan.

ADVERTISERS' INDEX

THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK OCTOBER, 1915

A Combined Heating and Sprinkler System for a Factory Building

PLANT OF WHEELOCK, LOVEJOY & CO., CAMBRIDGE, MASS.

By CHARLES L. HUBBARD.

The heating system for the new building of Wheelock, Lovejoy & Co., in Cambridge, Mass., is of especial interest from the fact that the heating and sprinkler systems are combined, thus reducing the radiating surface to about 30% of that required, if the usual system of independent heating were employed.

The building is approximately 170 ft. x 180 ft. in size, by one story in height, and is devoted to the storage of steel stock and the cutting and tempering of the same. While much larger buildings have been equipped with this system of heating, the present case is well adapted to purposes of illustration, owing to its simplicity.

Piping plans showing the layout for the combined heat and sprinkler system and the auxiliary heating system are shown in Figs. 3 and 4, respectively. Out of a total of 5,000 sq. ft. of radiation required, 3,800 sq. ft. are made up of the sprinkler mains and laterals, which would have to be furnished in any case. The auxiliary surface consists of twelve cast-iron radiators in the office section and a circulation along one side of the main work room, as indicated in Fig. 4.

HOT WATER HEAT USED.

The medium of heat transmission is hot water, which is heated in a 40 H. P. vertical tubular boiler and circulated by a centrifugal pump having a normal capacity of 150 gal. per minute at a speed of 700 R. P. M. The pump is driven by a 2½ H. P. belted motor, as shown in Fig. 5, and operates under a head of approximately 20 ft.

HOW SYSTEMS ARE CHANGED.

A sprinkler system is changed to a

FIG. 1.—PLANT OF WHEELOCK, LOVEJOY & CO., CAMBRIDGE, MASS.

FIG. 2.—INTERIOR OF WHEELOCK, LOVEJOY & CO.'S PLANT, SHOWING METHOD OF MAKING SPRINKLER CONNECTION IN HEATING MAINS.

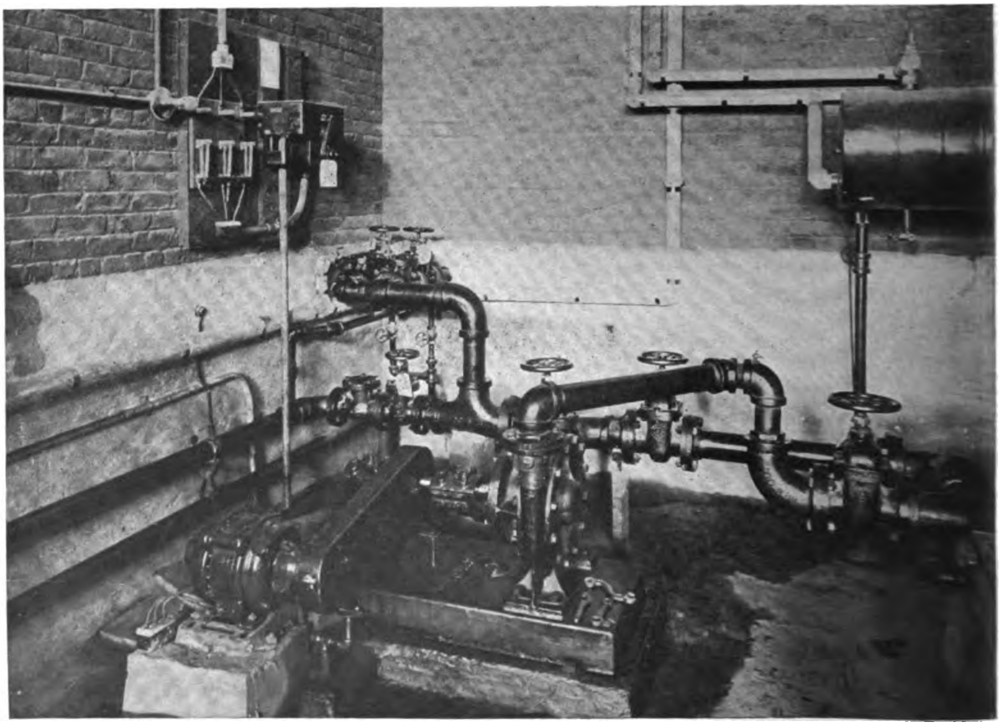


FIG. 5.—CIRCULATING PUMP FOR HOT WATER HEATING AND SPRINKLER SYSTEM IN PLANT OF WHEELOCK, LOVEJOY & CO.

heating system, without affecting its original purpose, by simply tapipng the ends of the laterals and bringing back return connections to the suction of a circulating pump which discharges through a heater into the sprinkler supply mains, inside the alarm valve.

In buildings several stories in height, sufficient circulation has been obtained by gravity, without the use of a pump. In general, however, forced circulation is usually preferable, for hot water heating large buildings, regardless of whether the combined or independent system is employed.

Circulating hot water through a sprinkler system has no effect upon its efficiency as a protection against fire. The pump and heater are in a by-pass connection, the regular pressure is carried at all times, and the supply of cold water in the sprinklers, in case of fire, is not affected in any way. The only details requiring change are shallow loops or traps in the sprinkler-head connections to prevent circulation and to keep the hot water from the fusible pieces, and provision for expansion. The method of making the sprinkler connection is shown in Fig. 2, and is very simple in construction. Expansion is provided for by the use of a closed tank, with an air cushion, or a by-pass may be carried around the alarm valve in the sprinkler system, this pipe containing a check valve opening outward and having a small hole drilled in the seat. When the volume of water in the system increases, due to expansion, the surplus passes into the city mains, or other source of supply, through the check valve. As the water cools, contraction takes place slowly, and the system is again filled through the small hole in the check valve seat.

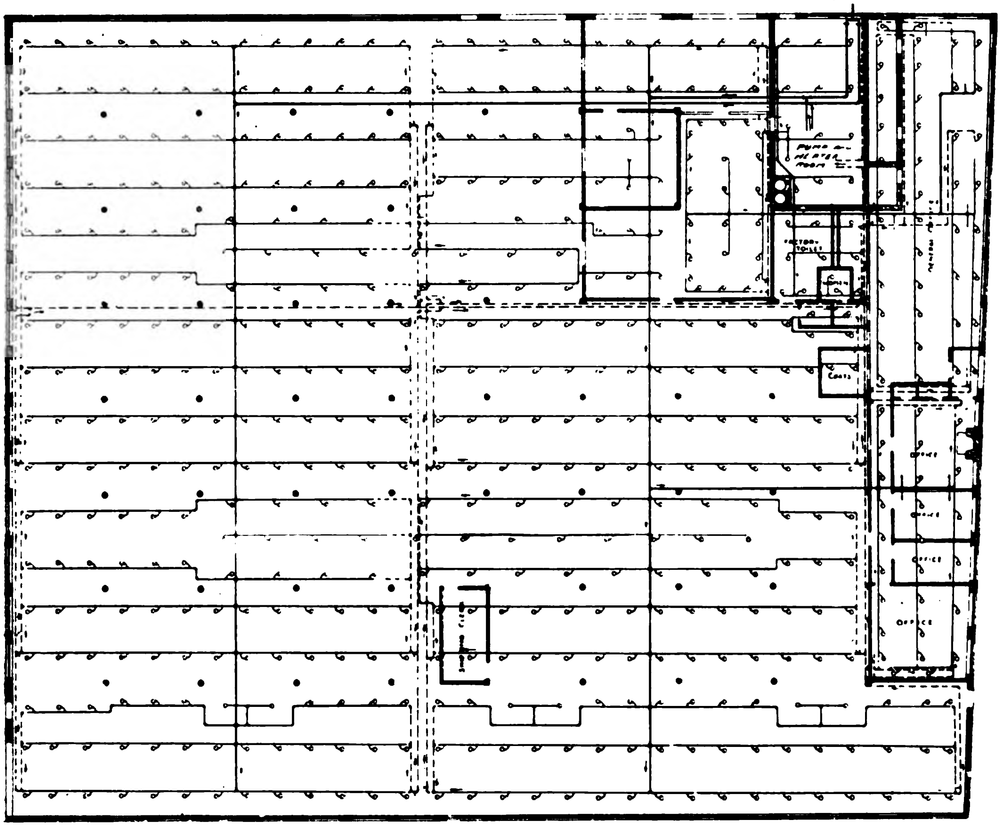


FIG. 3.—PIPING LAYOUT FOR HOT WATER HEATING AND SPRINKLER SYSTEM, PLANT OF WHEELOCK, LOVEJOY & CO.

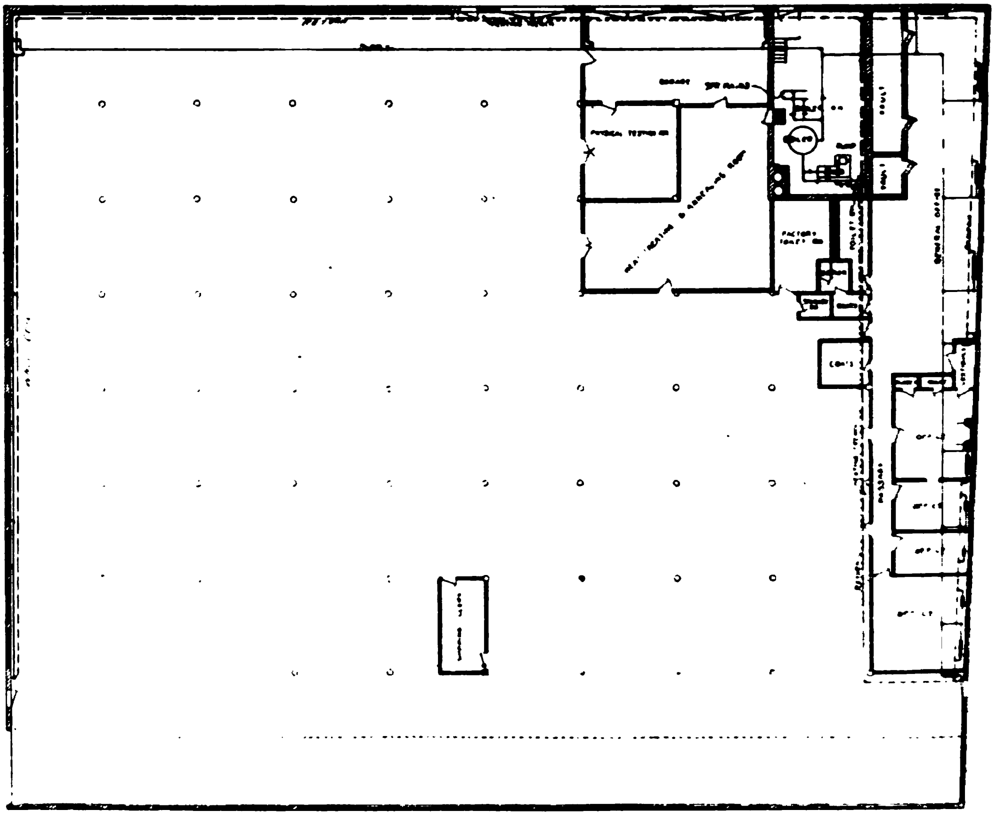


FIG. 4.—AUXILIARY HEATING SYSTEM FOR PLANT OF WHEELOCK, LOVEJOY & CO.

DESCRIPTION OF PLANS.

Referring to Fig. 3, the sprinkler system proper is shown in full lines, the returns by dotted lines, and the sprinkler heads as circles, while the direction of flow is indicated by arrows. The supply from the street main enters where shown, and then branches, two sections of the building being supplied through independent lines. Circulating connections from the pump and heater join the supply mains where marked and the returns are brought back as indicated.

The arrangement of pump, heater and connections are shown in Fig. 4, which represents teh auxiliary heating system The connections at the pump and heater are so valved that the main and auxiliary systems may be operated independently or together, as required, and the pumps may be by-passed for night warming by gravity if desired.

FIGURING A COMBINATION SYSTEM.

In making the computations for a system of this kind no changes are required from those regularly used in heating and sprinkler work as commonly installed.

In general, the sprinkler piping will supply from 60 to 70% of the needed radiation, thus greatly reducing the amount of surface in the form of coils and radiators, and also reducing the size of the mains and branches leading to the auxiliary surface.

In many buildings, or departments, the sprinkler surface will be sufficient for all of the heat required, while in others it will need to be supplemented more or less by auxiliary surface for use in the coldest weather. In some cases, where the desired increase is small, the sprinkler pipes may be increased in size sufficiently to make up the deficiency.

Water temperatures up to 250° F. may be carried without producing a rise at the sprinkler head of more than 25° above the temperature of the room, and temperatures of 70° to 80° in the pipes

will prevent freezing in the heads when the room temperature falls to 10° or 15° above zero.

This system is controlled by the Combined Heat and Sprinkler Co. of Boston, and the plant above described was installed by the Rockwood Sprinkler Co. of the same city.

Smoke Abatement in House Heating Boilers

BY MARTIN A. ROONEY, M.E.,
SMOKE INSPECTOR, NASHVILLE, TENN.

Practically all of the large cities of this country now have stringent ordinances directed against the emission of dense smoke from all classes of public buildings, including apartment houses, schools, etc., in which the commonly called house heating boiler is used.

By house heating boiler is meant usually the low pressure steel firebox, or the cast-iron sectional firebox boiler, and it has been amply demonstrated that these types are probably the greatest contributors to the volumes of smoke which menace life and property in our large cities.

When soft coal is burned in these furnaces (designed primarily for hard coal) all the laws of perfect combustion are outraged for

1. The rate of combustion, and, therefore, the temperature of the furnace is low.
2. The space provided for combustion is insufficient and no provision is made for mixing the volatile gases, and,

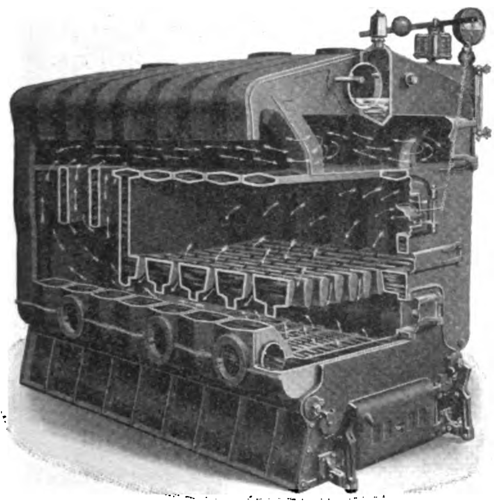


FIG. 1.—IDEAL SMOKELESS BOILER.
(American Radiator Co., Chicago, Ill.)

3. The volatile gases are brought into contact with the cool surfaces of the boiler before their combustion is completed.

To overcome these difficulties, numerous smokeless boilers have appeared on the market in the last few years and their number is being constantly augmented.

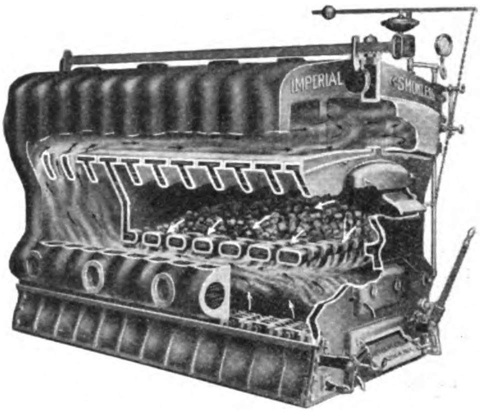


FIG. 2.—IMPERIAL SMOKELESS BOILER.
(Utica Heater Co., Utica, N. Y.)

All of these employ the down-draft principle in which the air supplied to the furnace and the combustible gases are drawn down through a bed of hot coals on the upper grate and over coals on a lower grate which have fallen through from the upper grate and are thus completely burned without smoke. The upper grate, called the water grate, has water circulating through it to prevent burning.

The various designs differ in the kind and arrangement of the upper grate and in other mechanical details.

CLASSES OF DOWN DRAFT BOILERS.

They naturally fall into the following classes:

A. Cast-Iron Boilers.
(1) With Cast-Iron Upper Grates.
(2) With Steel Upper Grates.

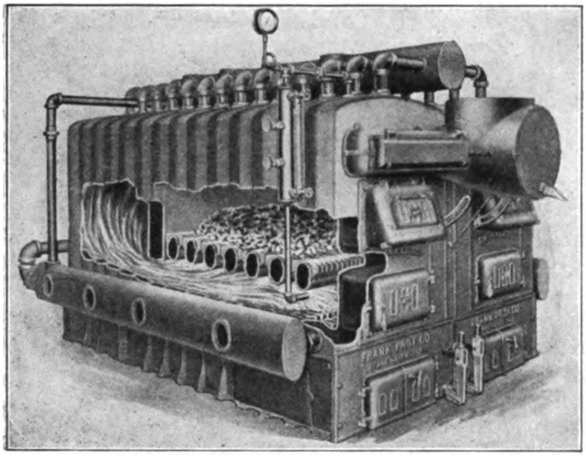


FIG. 3.—DUPLEX ECONOMIC HEAVY-DUTY SMOKELESS DOWN-DRAFT BOILER.
(Frank Prox Co., Terre Haute, Ind.)

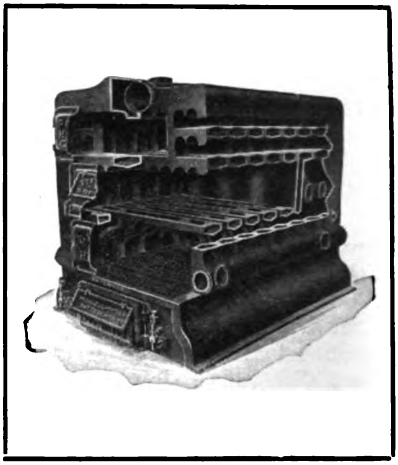


FIG. 4.—PEERLESS HEATER.
(Peerless Heater Co., Pittsburgh, Pa.)

(3) With No Upper Grates.

B. Steel Boilers.

The following brief description of some of the principal makes will serve to illustrate their points of difference. Figs. 1, 2, 3 and 4 represent the makes using cast-iron water grates. The manufacturers of this type claim the following advantages for grates cast integral with the sections:

1. That being cast integral, assembling the upper grate requires no additional labor.

2. That being of the same material the grates and sections expand equally.

3. That cast-iron does not corrode as rapidly as steel.

4. That larger areas are offered for water circulation than where comparatively small steel pipes are used.

The boilers shown in Figs. 5 and 6 have wrought-iron water grates. The advantages claimed for this arrangement are:

1. That with inclined grates there is less likelihood of scale deposit than with flat grates and,

2. That in case of the failure of a section of the grate exposed to the severe treatment of the fire and firing tools, repairs can be made without sending to the factory for parts.

A boiler without any upper grate at all is shown in Fig. 7. Its designers claim for it absence of all grate troubles, vertical circulation of water and large combustion space.

All steel boilers, of course, have steel water grates and those shown in Figs. 8 and 9 will serve as typical illustrations. The boiler shown in Fig. 9 has bent grate tubes and a deflection or mixing arch at

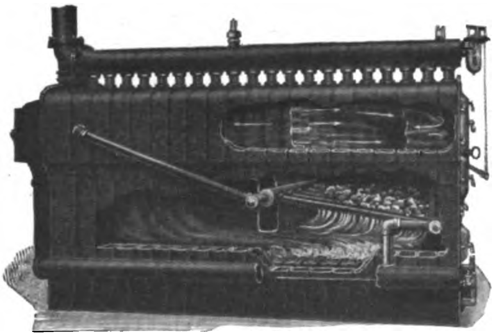


FIG. 5.—ROYAL DOWN-DRAFT SMOKELESS BOILER.
(Hart & Crouse Co., Utica, N. Y.)

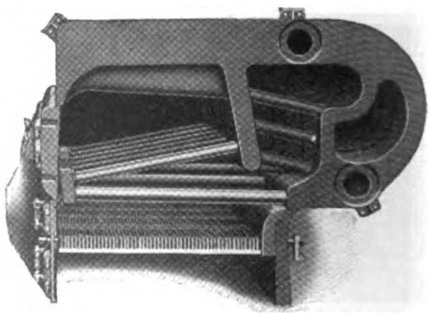


FIG. 6.—BERNHARD SMOKELESS BOILER.
(Kanawha Mine Car Co., Charleston-Kanawha, W. Va.)

the rear of the lower grate, features peculiar to this particular make.

OPERATION OF DOWN-DRAFT BOILERS.

Down-draft furnaces must burn their fuel more briskly and thicker fires must be maintained in them than in ordinary

FIX. X.—MOLBY SMOKELESS BOILER.
(Molby Boiler Co., Inc., New York.)

furnaces to obtain best results. This means that the always important question of draft must be given very careful consideration in installing down-draft furnaces. The stack sizes given in manufacturers' catalogues are, in many cases, too small. The thought in the mind of the manufacturer would seem to be that in competitive bidding the boiler requiring the lowest stack will be the cheapest, so that it is generally necessary to increase the size of the stack given in the manufacturers' catalogues to insure satisfactory results.

RULES FOR STACKS AND BREECHINGS.

The following rules for stacks and breechings have been used in several hundred cases with highly satisfactory results.

1. The top of the stack must be higher than any structure within 50 ft. of the stack.

2. The following table gives sizes of stacks:

Capacity of Boilers, Sq. Ft.	Size of Stack.
500	9 in. x 9 in. x 40 ft.
500 to 1,000	12 in. x 12 in. x 45 ft.
1,000 to 1,500	12 in. x 12 in. x 50 ft.
1,500 to 2,500	16 in. x 16 in. x 60 ft.
2,500 to 3,000	20 in. x 20 in. x 60 ft.
3,000 to 3,500	20 in. x 20 in. x 65 ft.
3,500 to 3,800	20 in. x 20 in. x 70 ft.
3,800 to 4,200	20 in. x 20 in. x 75 ft.
4,200 to 6,500	24 in. x 24 in. x 75 ft.
6,500 to 8,750	24 in. x 24 in. x 80 ft.
8,750 to 10,000	28 in. x 28 in. x 80 ft.
10,000 to 10,500	32 in. x 32 in. x 80 ft.
10,500 to 13,000	32 in. x 32 in. x 90 ft.
13,000 to 14,000	36 in. x 36 in. x 90 ft.
14,000 to 14,500	36 in. x 36 in. x 95 ft.
14,500 to 15,000	36 in. x 36 in. x 100 ft.

The above stack sizes are for boilers which are set not over 10 ft. from the stack, counting from center of stack to back of boiler, and allow for only one right angle turn in the smoke connection.

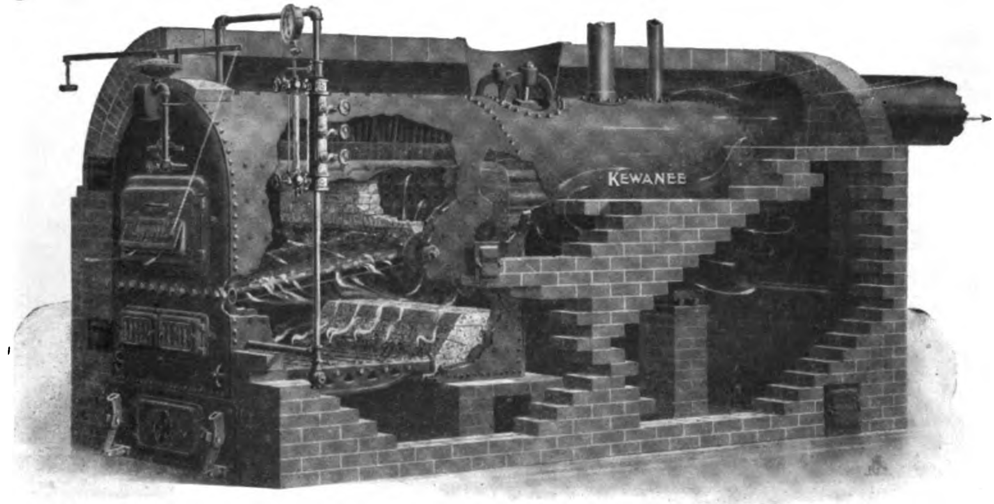


FIG. 8.—KEWANEE SMOKELESS BOILER.
(Kewanee Boiler Co., Kenwanee, Ill.)

For each additional right angle turn, add 10 ft. to the height of the stack.

3. All breechings should be as large as the smoke outlet of the boiler and should be free from dips, bends or restrictions.

After fire is started keep upper firebox *full*. When steam is needed stoke upper fire by pushing point of slicing bar along the surface of the upper grate, slicing coke through to lower grate. Don't poke surface of upper fire. Don't stoke immediately after adding fresh coal to upper fire.

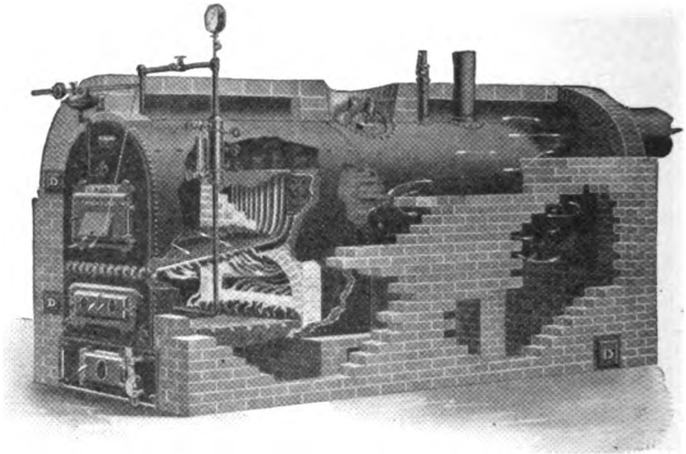


FIG. 9.—DETROIT SMOKELESS BOILER.
(John Brennan & Company, Detroit, Mich.)

Down-draft boilers can be operated just as easily as straight-draft boilers if the following simple directions are observed.

Starting fire. Place coal broken to not larger than fist size on upper grate, place wood on top of this and paper, waste or shavings on top of the wood. Put wood and shavings on lower grate. Light kindling on both grates. Leave upper door open.

Never put any fuel on lower grate.
Keep fire on lower grate clean.
Bank on upper grate.
Keep boiler flues clean.

With these boilers properly installed and operated it is easily possible to eliminate from 95 per cent. to 97 per cent. of smoke.

Definite Recommendations for Improving the Status of the Heating Engineer

A serious and carefully-planned effort to improve the status of the heating engineer is disclosed in the final report of a committee appointed by the New York Chapter of The American Society of Heating and Ventilating Engineers, consisting of Perry West, Newark, N. J., chairman; Frank K. Chew, New York; and J. I. Lyle, New York.

The committee lists its recommendations under eight headings and then proceeds to give practical suggestions as to ways and means for carrying out the recommendations.

MEMBERSHIP STANDARDS AND THE LICENSING OF ENGINEERS.

Under this heading the opinion is expressed that society membership should be a thing to be more sought after, also that a movement should be started for the legal licensing of engineers under the direction of State boards consisting of engineers selected by the national society, with, perhaps, a national board for deciding appeals from local boards.

THE STATUS OF THE ENGINEER IN HIS OWN FIELD.

In this connection the committee finds that the services of the engineer are too seldom employed and the field he works in is not properly cultivated, as is shown in the unproductiveness and size of the fees secured. It is also the belief that in a great many cases engineers could be employed to better advantage by the owner direct, as are other professional men. This system would give the engineer more authority for deciding engineering questions, such as is accorded other professional men in the decision of matters pertaining to their work. There is no working agreement between engineers, architects, contractors and manufacturers whereby each of these branches might be confined to its own particular field with better economic result to all.

Recommendations for the correction of these conditions are: 1. That a large portion of the activities of the society and of its business office be diverted from so many narrow and purely technical matters, and be put to work on the policy and business of engineering. Also that some plan be worked out whereby the engineers can co-operate with this movement in their every-day business life. 2. That a survey be made and action started toward more general, direct employment of engineers. 3. That a survey be made and action started on a working agreement between engineers, architects, contractors and manufacturers.

There is a great volume of heating and ventilating engineering, states the report, that is not being done by heating and ventilating engineers. To correct this economic defect it is urgently necessary that after qualifying by study, the heating and ventilating engineer take up the equally important business side of his work. He must ignore the moss-covered notion that his services should be sought. He must see to it that the value of his services is understood and that they are presented with the same frequency and dignified persistency with which the mere mechanical factors in the equipment are offered, explained, pushed, specified, sold and put into actual use.

The sale of engineering services needs to be given a positive impetus. Engineers are employed for an uterly inadequate proportion of the available work in their field.

During 1914, the cost of building operations in the United States amounted to $700,000,000, of which $70,000,000 might be considered the cost of heating and ventilating apparatus and the percentage of this sum which a reasonable fee would bring (say 5%), has not as yet been discovered by your committee as having reached our field. It might be considered that of this sum $750,000 came to heating and ventilating engineers, leaving $2,750,000 to represent the loss to the profession. Why? Because the field is not cultivated.

Some of the work not being done by engineers is being done by architects, principally under what we believe to be a false impression, that it can be so handled to the best interests of the work

as a whole. Some by the manufacturers, principally under what we believe to be a false impression, that it is a good and economic business proposition for themselves and the owner. Some is being passed over, principally under what we believe to be a false impression, that it is not worth doing.

Of the work being done by architects, there is no question but that some of this is being done well and especially is this true where regular engineers are employed on the architects' staff. The fact remains, however, that the guiding genius of an architectural office is not often so constituted by nature that he can look with an impartial eye upon two branches of work so different as architecture and engineering. Self-preservation compels the architectural viewpoint to subordinate the plain points of utility in engineering to the finer points of beauty and arrangement of the building. The result is that the engineering vitals often suffer and have their usefulness curtailed or destroyed; and in a great many cases without the architect's appreciating the gravity of the results.

The committee expresses its belief that the conditions might be improved in many cases by employing a consulting engineer direct and allowing him to be free to act in conjunction with the architect for the best interest of his client.

Of the engineering work being done by manufacturers, some of this is no doubt legitimate and proper for the promotion of new and special devices and systems, and in the furnishing of data upon which manufacturers are sometimes better posted than engineers. A great deal of complaint is heard against engineers for not being willing to spend the time and trouble to investigate new apparatus, and for not allowing free and open competition. It is argued by some manufacturers that it is necessary that they draw plans and specifications in order to get their share of the business. It is also argued that engineers are sometimes prone to undertake work for which they are not competent, and for which they lack the necessary experience. That they are further prone in a great many instances to spurn any data or consultation from the manufacturers. Under such conditions the manufacturer sometimes argues that it is a matter of self-defence for him to draw plans and specifications. The committee feels that in a great many cases the engineer is in the wrong and should as speedily as possible put himself in the right. Where these conditions do not exist, however, the system of manufacturers' drawing plans and specifications is wrong, both from an ethical and an economical standpoint.

In the first place, the manufacturer is generally forced to draw plans and specifications for no other compensation than what can be added to the cost of the work. This introduces the greatest temptation to use special apparatus that no one else can furnish, whether the same is suitable for the purpose or not. He is also forced, in order to include his own apparatus, to lay out the entire plan, including piping, electric and transmission systems, with which his engineering staff is naturally not so familiar as with his own apparatus and its immediate connections. In other words, the greater part of the layout is handled as a side issue and is not so completely handled as it would be by a regular engineer making such matters his whole business. He is also generally thrown into competition with other contractors, who are drawing their own plans and specifications, and as a result there are a number of such, all costing their respective concerns almost as much as one good set would cost a regular engineer. All of these costs must be borne sooner or later by the consumer.

In the opinion of the committee, a thorough understanding and a square deal by all parties concerned under this arrangement would work toward its immediate abatement and the final elimination of these conditions.

The Government, and a great many of the municipal departments throughout the country are maintaining either separate or co-ordinate engineering and architectural departments, and the State commissions and other similar bodies are requiring that architects in competition shall employ engineers satisfactory to the commission. It is evident that in such

cases the value of the proper handling of the engineering work is being appreciated. It is also noted that among the contractors there are quite a few now who are refusing to bid upon engineering plans and specifications which are not directly in charge of an engineer. This movement is not prompted by any personal or political motives, but is born of a spirit of self-preservation of the financial and engineering reputation of such concerns, against the making good of unforeseen troubles and the changing of work in place, where details are not properly worked out, and other evil effects of unsatisfactory engineering.

As to what is being done toward the elimination of the drawing of plans and specifications by manufacturers, some agitation has been carried on by this society, and the manufacturers themselves have had the matter up for serious consideration since 1910. As a result, a great many of the manufacturers have discontinued the practice, and the majority of the rest, we believe, are willing to do so as soon as they can see that it is to their advantage.

ENGINEERING FEES.

Under this heading the principal need mentioned is the standardization of fees. The following schedule is submitted and its adoption by the heating engineers' society recommended. The committee also recommends that the work started by the joint committee of The American Society of Heating and Ventilating Engineers and the American Institute of Architects be reopened for the purpose of showing the architects the wisdom and propriety of adopting the heating engineers' schedule, along with others:

	Cost.	Fee.
Residence heating jobs below	$1,000	$50.00
Repairs and alterations,		10%
New work	$5,000 or less	10%
New work	over $5,000	6%

A point is made of the fact that a great deal of engineering work is being done for less compensation that will provide for its being done propertly. A great many engineers appear to be sacrificing their own reputations, the high standards of the profession and the interest of the work as a whole, to commercialism and their own immediate interest; in other words, there seems to be a tendency to strive for large business at a small fee, and to turn out work which will not do credit to the profession.

An attempt to formulate some schedule of fees disclose the face that in 1900 and 1901 there was a conference between committees representing our society and the American Institute of Architects that resulted in an agreement that the owner should pay for such engineering service as the architect required. It remained for the society to formulate a schedule of fees for engineering services, and to reach some agreement regarding same with the architects, but as far as can be discovered this was never done.

We would call your attention to the following provisions which now exist in Section 3 of the American Institute of Architects' Principles of Professional Practice:

"ON SUPERINTENDENCE AND EXPERT SERVICE."

"On all work except the simplest, it is to the interest of the owner to employ a superintendent or clerk of the works. *In many engineering problems and in certain specialized esthetic problems, it is to his interest to have the services of special experts and the architect should so inform him. The experience and special knowledge of the architect make it to the advantage of the owner that these persons, although paid by the owner, should be selected by the architect under whose direction they are to work.*"

The committee considers these provisions indefinite and subject to improper use and interpretation. As such they form one of the weak points in what is otherwise a very rigid set of safeguards which the architects have chosen for regulating their professional ethics.

The architects could be shown that it would not only be to our advantage, but to theirs as well, to amend this section so as to include a mimimum schedule of fees for engineers, which would eliminate inferior engineering and its reflection upon our profession and theirs.

As the matter now stands, the architect in many cases collects the whole fee and pays the engineer out of same. With this arrangement the architect who would not break the rules of his profession by cutting his own fee may accomplish the same end by cutting the engineer's fee with impunity. This means that the architect who uses and pays for good engineering service, and by so doing is serving both his profession and ours and the public honestly, is at an unfair disadvantage with the architect who will cut the fees for the engineering.

The most important ethical point for the society to cover in the matter of fees is that in reference to residences, in which the service of the engineer is valuable to the last degree. For such work the engineer is so seldom employed that charges cannot be reliably given. Some engineers hold that the minimum should be $50.00; others say 10 to 15% and they claim to do some work at this rate. Others say not less than 6%. Others claim that for factory, school, church and public buildings, the work be divided into direct radiation plants and blower plants. Some office costs which have come to our attention run from 3½ to 4%, including inspection.

The above figures are for average size jobs and will vary some, but are considered a fair average and sufficient to show that practically all of the engineering which is being done below 5% is either being done at a loss, or is not productive of work which will probably be satisfactory to clients or creditable to the profession.

We have nothing now for the man who wants to obey the rules of law and order to conform to, nor for any engineer to point to as the recognized value of his services. Accordingly we have worked out a schedule of minimum charges.

A sliding scale schedule has been selected for three reasons: First, because other professional men have found it necessary and proper; second, because the office costs do not vary directly with the cost of the work; and third, because engineers will naturally scale their prices down as the size of the job increases, rules or no rules.

THE EFFICIENCY OF ENGINEERING.

It is stated in this connection that a great deal of engineering is being done poorly and so as to prove uneconomical simply to save time and cheapen the cost of engineering. This, it is said, is at the expense of false economy to clients and is a detriment to the profession. In the committee's opinion, the remedy for this lies in putting engineering on a better business footing and bringing the public to realize more fully that it is a paying investment.

Indications are also found tending to show that engineers are not turning out the best work that is in them and are not drawing the line closely enough between good work and short cut methods. As an illustration, the greatest number of piping, duct and transmission systems are designated from average tables, without going to the trouble to work out figures for particular cases.

Such individual handling of particular cases would often result in substantial savings from lower cost and better operation as a return for a comparatively small extra engineering fee. Such matters must be explained to the owners and architects, however, and there is apparently a reluctance on the part of engineers in using such means in promoting the advancement of the profession.

RESPONSIBILITIES OF THE ENGINEER.

The accepted arrangement of affairs today, according to the report, undoubtedly places unfair responsibilities upon the engineer. A movement should be started to rectify this condition and to prevent any tendencies toward further unfairness in this particular.

There also seems to be a tendency on the part of engineers to assume more responsibility, and to allow more of the burden of proof to be thrust upon them than is true of other professions. Owners and architects are also demanding that engineers guarantee and bond the proper working of their plants. Also a few engineers who are siding with this view. At the same time the architects and other professional men are not guaranteeing the results of their services, but are simply striving for the best and allowing the clients to take the risks. There is nothing in the ordinary engi-

neering fee to cover more than the barest compensation for services rendered, and surely nothing at all to cover any insurance of the risk, which is naturally attached to every business venture.

If such an extra fee is charged and understood the conditions are, of course, different, but it seems that this favoring of the engineers' guaranteeing their work is simply placing upon them an unfair handicap not borne by any other professions.

In this same connection a tendency is noted on the part of engineers to allow architects and others to shift the whole responsibility for the fitting of the engineering equipment into place (with the building and other items), on to the engineer's shoulders. The engineer is expected, not only to furnish all data as to sizes and requirements of his apparatus (all of which he should furnish, of course), but is sometimes required to follow up and check architectural plans and see that these requirements are met. Furthermore he is expected to check the architectural plans against all interference between his work and that of others. After this he is required to follow up on the job and see that the architect's plans and specifications are followed out, as far as his work is involved, and that nothing is installed to interfere with the engineering work.

This involves looking after a great volume of work upon which no fee is ever figured for the engineer. He is also expected to be perfectly familiar with the building and all other kinds of plans, whereas others on the job are most generally very ready to disclaim any knowledge of the first meaning of an engineering plan.

Furthermore, too many engineers are apt to allow their contractors to be burdened with unfair responsibilities and burdens of proof. Such as the changing of work in place, where the fault lies with someone else, and the sole proving of their claims in this connection, whereas, some of the burden should rest with the other contractors involved. The unfair treatment of a contractor in this way tends to increase the cost of the next job and to embitter the contractor against engineers.

Under this heading of the shifting of responsibility, there is also noted the tendency of engineers to shift a part of their own responsibilities, such as supervision and details, to others, so as to cheapen their services; but, of course, this is at a greater cost to the job.

THE SEPARATION OF CONTRACTS.

The committee endorses the movement for the separation of contracts, "broadly speaking and on public work in particular." It believes that a great deal of harm is resulting from the practice of letting the engineering contracts as a part of general contracts, if the general contractor has neither financial nor moral responsibilities. In a number of States there is a law against this on public work.

The master fitters and plumbers are working in the interest of such laws in a number of States. In other localities engineering contractors are handling the situation by refusing to bid to general contractors of the kind mentioned. The resolution passed at the last meeting of the American Institute of Architects in New Orleans is quoted in full, as well as the following resolution passed by the National Electrical Contractors' Association in July, 1914:

"Resolved, that the National Electrical Contractors' Association of the United States, in convention assembled, concurs in the resolution adopted by the American Institute of Architects last December, at New Orleans, covering the segregation of plumbing, heating and electrical equipment, from building contracts; and that a copy of this resolution be sent to the Secretary of the American Institute of Architects."

The proper handling of such work involves the maintenance of departments; they are not as capable of properly supporting as are the engineers, who are regularly engaged in this particular work. They are also naturally lacking in the proper viewpoints which are very essential to the best interests of any undertaking.

This does not mean, of course, that all work so handled is suffering, but it seems to be pretty well proven, that the system is objectionable and that abuses are being practiced to such an extent as to warrant the serious consideration by

all parties concerned, of changing the system, especially on all public work.

EXAMPLES OF SOME OF THE ABUSES.

The following might be cited as examples of some of the abuses, which are working to the detriment of the engineer and sub-contractor.

We have all realized for some time, that the irresponsible general contractor, in a great many cases, does most all of his business on the sub-contractor's capital as follows: The general contractor, receiving the payments, naturally holds the whip hand, and upon one pretext or another, may hold up payments, thus accumulating money upon which to run his business, while the sub-contractor must meet his bills for material and labor in the meantime. If the general contractor fails, the sub-contractor has no recourse on the owner, who can take his labor and material for which he has received no pay, just the same as that for which he has been paid.

The sub-contractors are also saddled with all kinds of claims for delays and penalties and with the responsibilities for non-compliance with plans and specifications, and in a great many cases very unreasonably so, and may be made to submit under penalty of not receiving their payments.

It is also difficult to secure an equitable settlement of disputes and claims arising between the work of the general contractor and that of the sub-contractors, due to the fact that the other parties concerned are represented before the architect and owner by the general contractor, who is naturally their opponent in such matters.

Again the owner may pay the general contractor a fair price for his equipment (based upon a good fair price from the sub-contractor to the general contractor at the time bids are taken) and the general contractor may shop around and either beat his sub-contractor down, or get an incompetent cheap substitute to do the work. Of course, in either case, the work is never as well done by an incompetent man, or by a competent one who has been beaten down in price, as by a competent one at a fair price.

Again, if the principal representative (among the contractors) is one having the greatest interest at heart in the building only, he will make the equipment, which is of great importance, so subservient of the rest, that it is impossible for the engineer or sub-contractor to secure the best results.

Also in cases where contracts are taken too low, or where the contractor may be desirous of securing an unfair profit at the expense of the owner, it is an easy matter for him to squeeze this out of sub-contractors, upon whom the blame can be laid and against whom the owner has no recourse. In the case where a general contractor takes work too low, he generally fails to realize this until most of the building contracts are let, and then whatever deficiency is to be recouped, must be made up out of the equipment.

In all of the above arrangements, the sub-contractor is the first loser, but the architect, the engineer, the general contractor, and the owner are perhaps greater losers, in the quality of the work, and general results attained; since the sub-contractor could well afford to do work better and cheaper under fairer and more agreeable conditions.

The principal argument the owner and the architect have against any of the above, is that by the employment of a general contractor, they are relieved of a great deal of responsibility and have only the one head to deal with, who is responsible for the full completion and co-ordination of the several branches of the work.

This argument can be shown to be a small matter, however, in comparison with the opposing evils as outlined above. It is a further fact, too, that the architect and owner by not coming into direct contact with the equipment work, have no direct assurance of what they are getting, or that this very important branch of the work is getting a fair and proper consideration. This whole matter goes back to the old proverb that "Whatever is worth doing, is worth doing right," which means that the architect and owner will always be well paid for their trouble in this connection.

As to disputes which may arise among several separate contractors, these arise

just the same under general contract. The only difference is, that the architect and owner do not hear so much about them, as a consequence, the work suffers.

These differences practically disappear whenever each contractor fully understands that the owner is to be the final court of decision and that each will get a fair and equitable hearing.

METHODS OF PROCEDURE.

In addition to its recommendations the committee outlines a definite method of procedure to accomplish the desired ends, as follows:

First. Deliberation and satisfaction with small returns to start with.

Second. The inviting of the appointment of a committee of one (1) from the architects, owners, contractors and manufacturers, to co-operate with the heating engineers in this movement. It should be made plain to these outside bodies that they are not to be committed to anything by the action of their representative, but that they will be thus kept in touch with the movement and would be expected to act through their own body as they saw fit.

Third. Circularizing the engineers of the East, sending each a copy of this report with the following questions:

Just indicate on a plain piece of paper the amount of your last year's fees and the highest, lowest, and average percentage which you received for your work, and mail same in a plain envelope to the chairman of this committee.

Also please send us your comments on the correctness and value of this movement, and state as to whether you will give same your support.

Fourth. Circularizing the engineering contractors throughout the East with a copy of this report and the following questions:

What is your opinion as to the correctness and value of this movement?

Will you give same your support and co-operation?

State the volume in dollars and cents of your last year's business.

What percentage of this was handled by engineers who are not contractors?

What percentage by engineering contractors?

What percentage by architects without regular engineering services?

What percentage without any engineers?

State what you know about the relative satisfaction to all concerned as given by the different jobs under the above differing methods of handling the engineering?

Your reply may be on plain paper, unsigned if desired, but please reply to the best of your ability.

Fifth. That the above data be used to start a set of statistics on the causes and effects of our status and the devising of means to better same. Also that this be followed out in the continued gathering of statistics and data to guide in this work.

Sixth. Practitioners in other professions require to be licensed by law and to have a State Certificate before they are allowed to practice. This is not true of the engineer and some of the above conditions are the result. A campaign is therefore for the passage of laws on this subject in the various States.

Seventh. That immediate steps be taken to interest every one possible in this work and that everyone of our members make it a special point to so interest himself. It is further recommended that every engineer first square himself with this movement and offer his objections and recommendations, and then after it is turned out as a finished product, let everyone constitute himself a committee of one to promote the idea. The committee states that it does not wish to be misunderstood, or to see any misunderstanding creep in which would stamp this as a revolutionary movement designed to create any Utopian conditions in the immediate future. It does believe, however, that there is a lot to be gotten out of concerted action in this field, and that a continuation of this work will produce results which will accumulate for the good of the profession.

Apparatus for the Study of Heat Radiation

BY JAMES D. HOFFMAN.

(From a Paper Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, at Atlantic City, September 16 *and* 17, 1915.)

The apparatus described herewith was outlined by Professor James D. Hoffman and developed by G. C. Polk and L. C. Lichty, two senior students in the mechanical engineering department of the University of Nebraska.

Among the suggestions that prompted the development of the apparatus were the following:

1. In burning a stated amount of fuel does the total amount of heat given off as radiant energy remain the same for all rates of combustion? That is, having a number of equal samples of coal to be completely burned, each sample to vary in time of burning, will the heat radiated be a constant amount?

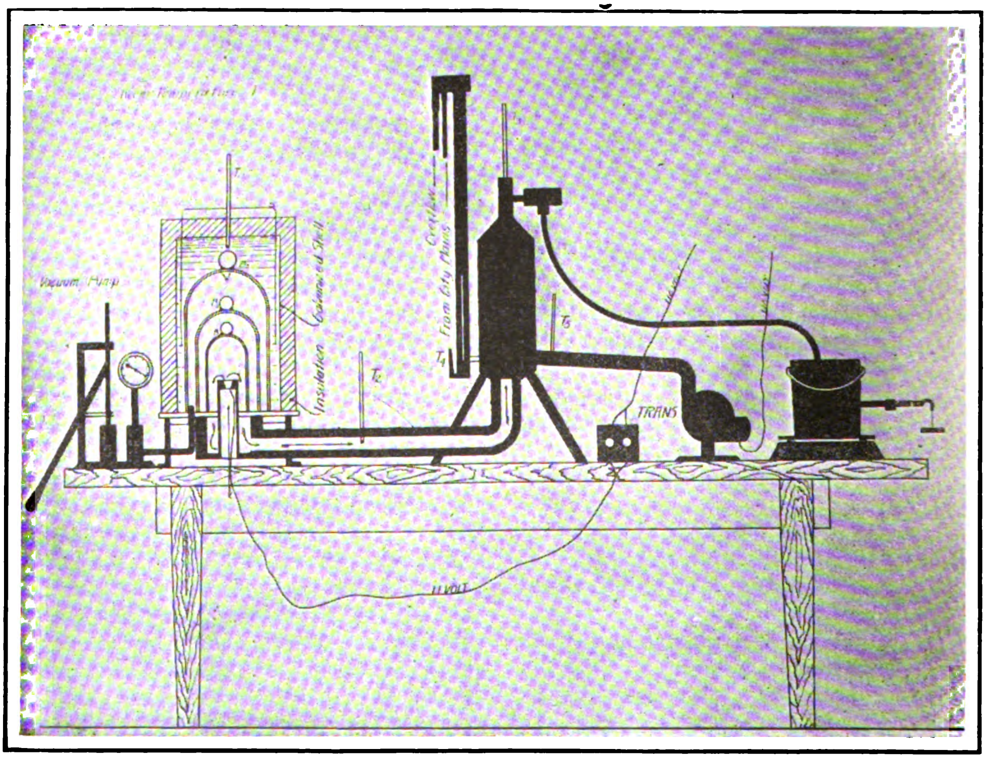
2. Is there a definite relation between the heat given off as radiant energy and that carried off by convection?

3. Is there one rate for combustion for every fuel that is the most economical rate?

4. In burning a given amount of fuel in a given time is it more economical to reduce the grate area and increase the rate of combustion?

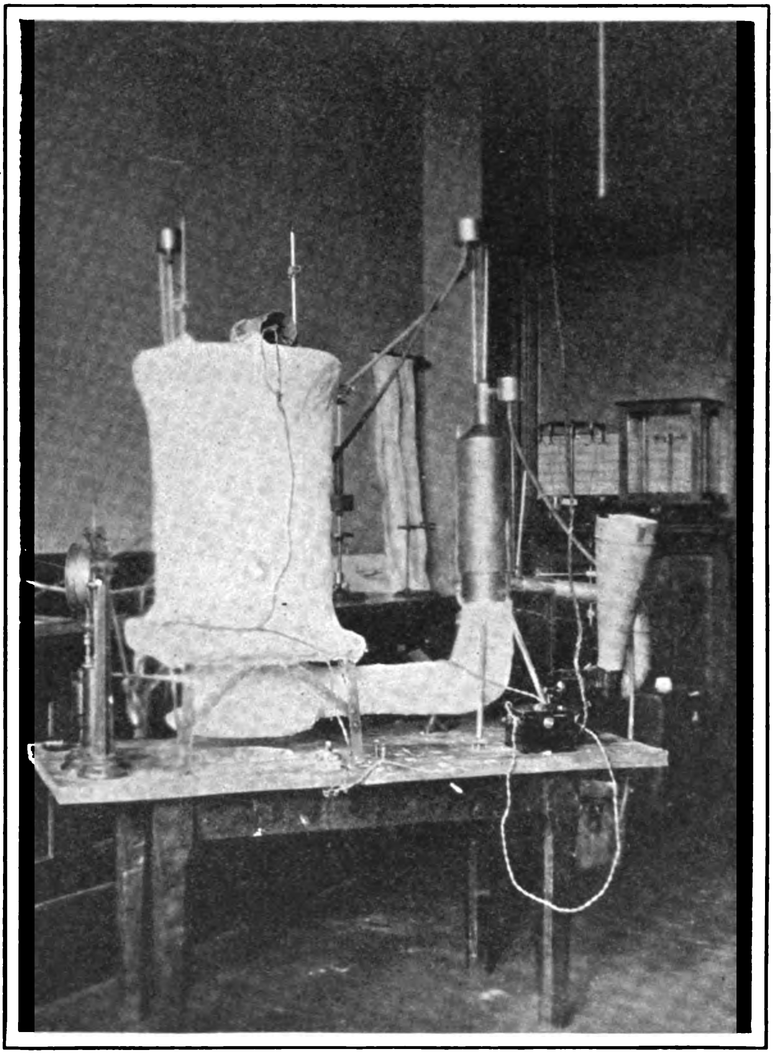
Professor Hoffman states that after conducting a number of tests with the apparatus the data obtained seemed very encouraging, but not at all conclusive. It is evident that much more work will have to be done if dependable results are to be obtained.

Fig. 1 shows the assembled apparatus. It comprises two calorimeters (one to measure the heat radiated and the other to measure the convected heat), a vacuum pump, a transformer, an electric motor fan and a weighing scale. All



APPARATUS FOR DETERMINING HEAT RADIATION.

the apparatus is standard except the calorimeter for measuring the heat radiated. This consists of a metal fire tube enclosing a clay fire pot through which the room air enters the combustion chamber (this tube is adjustable for height); one glass bell-jar, B_2 to protect the bell-jar B_2, from excessive heat; two bell-jars B_2 and B_3 enclosing an air tight compartment V (this compartment is connected with the vacuum pump); and a galvanized tank heavily insulated, forming a water chamber around bell-jar B_3. This water chamber is provided with a stirring device which is used just before taking readings. A peep-hole is arranged through the insulation at the side of the calorimeter and a reflector below the fire tube to observe the fire. Provision is made for temperature readings as follows:



TESTING APPARATUS IN OPERATION.

Temperature of room ....T
Temperature of water in radiant heat calorimeter ....T_1
Temperature of gases leaving fire chamber ....T_2
Temperature of water leaving Junker calorimeter ....T_3

Temperature of water entering Junker calorimeter ....T_4
Temperature of gases leaving Junker calorimeter ....T_5

The desired velocity and volume of the gases are obtained by a variable speed motor-fan and an anemometer located at the fan outlet. The pipe carrying the gases between the two calorimeters is thoroughly insulated. Any air pressure may be maintained in chamber V.

During the series of tests four degrees of pressure were maintained atmospheric, 10 in., 20 in. and 28 in. To assist the fire in starting, an eleven volt circuit with platinum glow is placed in the fire pot. The equivalent heat given off by this circuit is finally deducted from the experimental summation for the heat balance. Fig. 2 shows the apparatus in the process of construction and Fig. 3 shows it completed.

The method of procedure in burning any one sample of fuel is as follows: water is circulated through the Junker calorimeter and upon the temperatures T_3 and T_4 becoming constant the switch is closed, thus lighting the fire and starting the motor. The fuel usually begins to flame in one minute and the wire is kept hot for two minutes. After the first two minutes, the speed of the air is regulated to some definite speed so as to give a uniform rate of burning. As soon as the fire is out the velocity of the air through the anemometer is increased to 100 ft. per minute and kept constant until the end of the test to cool down the apparatus All tests are run until the temperature of the incoming gases T_3 becomes constant, which usually occurs at one or two degrees above the room temperature. Then the fan is shut down and the water allowed to keep flowing through the Junker calorimeter until the difference between T_3 and T_4 is the same as at the beginning of the test. All thermometer and anemometer readings are taken every two minutes. The water is weighed at convenient times during the test. The residue left in the fire pot is weighed after each test and deducted from the amount in the original sample in each case. Analysis of heat values may be made of some of the original samples to obtain a basis of comparison.

The improvised calorimeter has given very satisfactory results in all points but two. First, the sample of fuel has never completely burned. Fire pots of varying shapes and sizes were tried and the total heat obtained from the test, i. e., the heat radiated across the vacuum to the water, plus that obtained in the Junker calorimeter, minus the heat equivalent of the electric circuit, never exceeded 95% of the heat value of the fuel as obtained by separate tests. Second, fuels with high hydrocarbon content had a tendency to coat the inner bell-jar and retard the radiant ray. No difficulty was experienced in maintaining the highest degree of vacuum in the space V or in otherwise handling the apparatus.

All things considered, the experimental results thus far obtained seem to justify further research.

THE BUSINESS OUTLOOK.

I.

By Frank M. Huston,

Financial Editor of the Chicago Evening Post; Editor Rand-McNally Bankers' Monthly.

What is needed in this country most at the present moment is some of the old indomitable courage in the business world. Because there seems to be no precedent to be found in history to act as a financial guide in the present many seem to be disposed to pause and allow a golden opportunity to pass. A few long headed courageous men are quietly taking advantage of the lull to build future business.

It was the late J. Pierpont Morgan who made a remark a few years ago that has since become almost an axiom, warning people never to become a bear on the possibilities of this country. Mr. Morgan had the courage of his convictions and the son is following in his father's footsteps. He and other banking firms, such as Kuhn, Loeb & Co., are taking advantage of existing opportunities in arranging for a large credit for the European belligerent countries here, thus performing a greater service than most people imagine. These banking firms are not to be considered philanthropists. They are performing a service, it is true, but as a matter of fact they are good, far-sighted business men.

There is a big profit in this war banking and they propose to get that profit. In getting it they are bringing this country a large volume of business that we

need to keep our mills in active and continual operation, in a time of lax domestic business. But is this lax business, this restricted activity, really justified, even with the greatest war in all history under full sway in Europe? Let us see. It is true this war is destroying a very large amount of property, of wealth. This property or wealth is the basis of credit. It is not necessarily money. It is certainly not reserve money, as accepted in most nations of the world, that is being destroyed. In fact, practically no gold has been destroyed in this war, while gold accumulations as reserve have increased. Gold that has been hoarded has come out of hiding and gold used in the arts (jewelry, etc.) has been turned in and exchanged for credit.

Thus it will be seen that reserve money has increased, while wealth has decreased to the extent of the property destruction and the destruction of munitions of war and curtailed activity. Contraction of wealth means ultimately a contraction of credit. Just now, however, reserve money is accumulating and being hoarded in Europe, and this makes possible an enormous inflation of currency. A government in time of stress uses its credit just as does the individual or corporation. This is sound financing, providing it is not carried beyond actual needs. Sound principles of finance require that deflation take place as fast as the requirements for use of the credit pass.

Increased currency emissions and rapid circulation stimulate business; over-inflation brings currency depreciation. This is what Europe is now experiencing.

In this country we expanded our currency to meet the requirements of business here when our international credits became temporarily of no use as a banking asset. The moment that condition cleared, the emergency currency was retired. Our currency, therefore, is deflated, until it is now in about normal volume.

This country, therefore, is in a fundamentally sound position to meet any shock that might come out of the war. Our crops are very reassuring. A large yield of wheat, a big crop of corn and oats and other cereals will add something like $9,500,000,000 to our wealth. This is a basis for nearly $30,000,000,000 of new credit.

This means additional buying power in the agricultural sections and the small towns. This additional buying power, together with the benefits accruing from the war orders, affording employment to thousands of artisans, means the consumption of more merchandise of every sort, more building, more business for the carpenter, the heating contractor, the plumber, the lumberman, the brickmaker, the hardware merchant, and so on down the line. In fact, all lines of trade will be stimulated in consequence.

For many months, excess conservatism on the part of various lines of trade and of the consumer has resulted in a hand-to-mouth buying policy. With fundamental conditions sound, and with the necessity growing for a replenishment of many of the necessaries, there is every reason to look forward to a gradual expansion in business.

What is needed at the moment are courage and confidence. It will not do to sit idly by waiting for the economic readjustment that will follow the war. That may be years in developing; and, when it comes, we will be better able to accommodate ourselves to the new conditions because of our having proceeded in the meantime conservatively, but in a courageous way, to care for the business that is at hand. Speculation, of course, is to be avoided, but there should be no fear in reaching out for legitimate business in various ways. For the resumption of business depends upon the confidence and the courage to reflect it in business intercourse, and one may well base this confidence on the good physical and financial conditions of our country.

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FOR SOME time those having the interests of the heating profession at heart have been endeavoring to place the profession on a higher plane by having this branch of engineering taken up by the colleges and universities in the form of a special course, with, possibly, a degree to be offered to graduates. It was felt that since a few of the universities were already giving a more or less exhaustive course on this subject, the time was ripe for inducing other institutions to follow their lead. Very little encouragement has been forthcoming, however, for two reasons. One is that the universities as a whole are not yet ready to admit that heating and ventilating is sufficiently distinct or advanced as a science to warrant a separate course. The other is more practical; it involves an assurance on the part of the trade and profession that places will be found for the graduates. In other words, the universities are perfectly willing to adopt a heating and ventilating course provided they may be sure it is going to be a practical success. This may smack of commercialism in educational affairs, but the proposition has considerable logic in it.

It is with this state of affairs in mind that the American Society of Heating and Ventilating Engineers has come forward with a proposal to start an engineering course on its own hook because, in the words of those who are fathering the idea, "it is realized that there is now opening a far greater need for the continuance and extension of the services (of heating engineers) to the profession and to mankind . . . and it is highly desirable for the general development of the profession, and for its greater usefulness to mankind, that entrants into these branches of engineering be as adequately prepared as are men who enter other branches of engineering;" also that "the dignity and usefulness of any branch of professional endeavor must depend upon the thoroughness with which its practitioners are equipped to cope with the problems which arise in their respective fields," and that "the greatest good may accrue to the heating and ventilating profession from a broad policy for the classification and dissemination of highly specialized knowledge."

While the plans, of course, are still in the formative stage, a fact that will assume increased prominence as the work proceeds is that heating engineers have "too infrequently been accorded the wide publicity which characterizes the common knowledge of other branches of engineering." This well expresses the issue and if nothing more is accomplished than the preparation of an instruction course that will serve as a standard or model for adoption by institutions of learning, it will go far toward giving the art the prominence and publicity it merits.

American Society of Heating and Ventilating Engineers

Semi-Annual Meeting, Atlantic City, September 16 and 17, 1915

If anything like the plans proposed at the semi-annual meeting of the American Society of Heating Engineers in Atlantic City September 16 and 17, are carried out, the society will shortly inaugurate the most ambitious movement in its history to give wider publicity to the heating and ventilating profession. The plans involve the formulation of a course of lectures on heating and ventilating engineering, to be conducted under the auspices of the society. Various members of the society who are specialists in their line will be asked to contribute lectures with especial reference to their specialty. In this way it is hoped to develop a lecture course that will be more comprehensive than anything that has as yet appeared, and which will serve as the basis of a university course to be offered to the different universities. In the meantime the plan is to have the lectures delivered in those cities where society chapters are located.

The matter of the pressing need for wider publicity for the work of the heating and ventilating engineer came up through the report of the New York Chapter's Efficiency and Welfare Committee, the principal portions of which are published on another page of this issue. In an impressive discussion of this report, M. W. Franklin called attention to the underlying reasons for the present state of affairs and presented his suggestions for meeting them that were later crystallized in a resolution for a society course of instruction.

Mr. Franklin pointed out that all the trades have developed in advance of engineering. Buildings came before architects. In every line the engineer has developed after the art was established, and in many cases only after buildings became complex in their construction and equipment. It was so with electrical engineering and with mechanical engineering. At first, for instance, electrical manufacturers made motors and lamps by rule of thumb. Then as the trade developed it came to have electrical engineers who put the trade on an engineering basis.

During all of this development work the manufacturers had to act as consultants to get their apparatus used. In this way a class of experts was developed that linked the manufacturers with the consumers. The status of the engineer in Europe has advanced to such a point that when a man has, for instance, an electrical project in view, the first man he consults is the electrical engineer. There is no difficulty in getting the proper fee in the electrical field.

The trouble with heating and ventilating is that it is not recognized as a vital part of the construction. It is necessary to get the heating engineer more widely known. He is now regarded merely as an adjunct and accepted without being recognized.

Mr. Franklin referred to the new Government advisory board made up of experts in engineering lines and declared that the most important line of all had been ignored in the formation of the board—that of heating and ventilation. Submarines, for instance, cannot operate without good ventilation and yet there is no distinctly heating and ventilating expert at work on this problem.

Mr. Franklin's conception of engineering placed the subject in a new light. We have, he said, the purely scientific field and the commercial field. Engineering is a combination of these two. It is the link between the scientific methods of the laboratory and those of the commercial investor.

After further discussion of the subject the society adopted a resolution offered

by a committee composed of M. W. Franklin, J. A. Donnelly and Frank K. Chew recommending that a committee be appointed to consider the establishment of a course of study in heating and ventilating engineering and to prepare plans and recommendations to be presented at the next annual meeting in January.

Following is the full text of the resolution:

"Whereas the American Society of Heating and Ventilating Engineers has exerted an acknowledged influence for good on the practice in its special field, and those allied to it, and

"Whereas it is realized that there is now opening a far greater need for the continuance and extension of the services to the profession and to mankind, and

"Whereas courses of instruction in these branches of engineering are not generally available in the universities and engineering schools, and

"Whereas it is highly desirable for the general development of the profession, and for its greater usefulness to mankind, that entrants into these branches of engineering be as adequately prepared as are men who enter other branches of engineering, and

"Whereas the dignity and usefulness of any branch of professional endeavor must depend upon the thoroughness with which its practitioners are equipped to cope with the problems which arise in their respective fields, and

"Whereas the greatest good may accrue to the heating and ventilating profession from a broad policy for the classification and dissemination of highly specialized knowledge, and

"Whereas this society numbers among its membership many capable experts whose knowledge has too infrequently been accorded the wide publicity which characterizes the common knowledge of other branches of engineering;

"Therefore, we respectfully recommend that The American Society of Heating and Ventilating Engineers should authorize the appointment of a committee to present at the annual meeting of the society, in January, 1916, plans and recommendations for a graduate course, to be given by the society, in the fundamentals of heating and ventilating engineering, and the allied branches, whose object will be adequately to prepare engineers more advantageously to enter upon the practice of heating and ventilating engineering."

The resolution was signed by Milton W. Franklin, Frank K. Chew and James A. Donnelly.

First Session, Thursday Afternoon.

Considering the fact that the place of the meeting had been changed from San Francisco to Atlantic City at a late date, the registration of about 60 members and guests was well up to expectations. The professional sessions were held in the solarium of the Marlborough-Blenheim Hotel, directly facing the sea. It proved to be as cool a spot as could have been selected, for the weather was notably hot, although the evenings were clear and mild.

The first session was opened by President D. D. Kimball. After referring to the efforts that were being made to increase the society's membership, he urged that an amendment to the constitution be passed at the next annual meeting providing for the election of new members by the council instead of by the membership as at present. The present method he said, was unnecessarily expensive and cumbersome.

As a result of the inauguration of the society Journal, President Kimball said that the society's income had increased from $6,500 to about $10,000 a year. This has made it possible to publish the Proceedings to date and still leave a balance in the treasury.

Reports were then read from the Illinois, New York and Massachusetts Chapters covering their work for the year. Announcement was made that Vice-President Frank T. Chapman was unable to attend the meeting on account of illness. This led to the passage of a resolution by the meeting that a message of greeting be sent him, with best wishes for his speedy recovery.

At this point the chairman introduced D. L. Gaskill, secretary of the National District Heating Association, who was in Atlantic City in attendance at a meeting of the executive committee of that body. Mr. Gaskill pointed out that, while the general scope of the two societies was sufficient to justify the existence of each,

there were nevertheless many items on which they could co-operate with mutual advantage, such as the work of the educational committees and he urged a wider and fuller exchange of information and other data.

A report was presented of the committee to co-operate with the National Fire Protection Association, A. M. Feldman, chairman, which gave further information of the modifications which had been secured by this committee in the requirements of the National Fire Protection Association. Attention was called to the fact that in the effort to provide all the desired safeguards against fire, the fire protection interests were liable to impose undue restrictions on the installation of heating and ventilating apparatus and that the society should be careful to watch the promulgation of new requirements. James A. Donnelly stated that this was all the more important, because laws may often be overlooked, but failure to comply with the requirements of the fire underwriters means the refusal of fire insurance.

REPORT OF COMMITTEE ON EFFICIENCY AND WELFARE.

Probably the most important report presented at the meeting was then taken up. This was the report of the New York Chapter's committee on Efficiency and Welfare, Perry West, chairman, which had been referred to the society by the New York Chapter. As will be noted from the abstract of the report on another page of this issue, the subjects taken up include membership standards and the licensing of engineers, the status of the engineer in his own field, engineering fees, the efficiency of engineering, responsibilities of the engineer, the separation of contracts, co-operation with others and, finally, the principles of professional practice. In a written discussion Mr. West stated that there have been very few, if any, tangible results since the movement was started by the New York Chapter last February. "Outside of seeing," he added, "that most of our members survived the shock which they underwent when we first advanced the idea last spring that the engineer should be the man to control engineering, which means the biggest end of all construction undertakings, and every now and then hearing some of our members talk out real loud along these lines, we are not able to point out many other results. As far as my observation goes, engineers in the meantime have been catering largely to other interests, cutting each other's throats occasionally and sitting by while the profession is being made a general football by those who come in contact with it."

In connection with the matter of engineering fees, Stewart A. Jellett, who was present, gave an account of the early efforts of the society in this direction some ten years ago. The matter was taken up at that time with the American Institute of Architects and eventually a resolution was adopted by the architects providing for the payment of engineering fees in addition to the architects' fees, where the work required engineering services.

Mr. Jellett expressed it as his belief that the trouble was not so much in connection with a schedule of charges as it was due to the fact that many heating engineers do not approach the problems presented to them from the owners' or from an engineering standpoint. Too often they look to see how much they can get out of it. Some engineering propositions, for instance, will not pay commercially and engineers should not lead owners astray by endorsing plans for improper or incomplete equipment.

Mr. Jellett also spoke of the practice of some manufacturers to make elaborate plans and declared that it was frequently the only way by which they can bring their specialties to the attention of the public. This practice, however, makes it difficult for the heating engineer to obtain commensurate fees on small work. There are more opportunities for securing suitable fees on large work.

Speaking to the same report, Mr. Donnelly made a plea for greater attention to the matter of engineering education and declared that the heating engineers' society should induce the colleges and universities to grant degrees in heating and ventilation.

At this point the president was au-

thorized to appoint a committee to carry on the work of the New York Chapter's Efficiency and Welfare Committee.

Mr. Donnelly then presented his paper on "Establishment of Standard Methods of Proportioning Direct Radiation and Standard Sizes of Steam and Return Mains." This paper formed part of a report presented before the National District Heating Association and was published in part in THE HEATING AND VENTILATING MAGAZINE for July, 1915. In the discussion of the paper S. Morgan Bushnell commended the methods given for figuring radiation as he had made a number of tests in which he checked the average amount of fuel consumed in certain buildings and in comparing the results with those theoretically required, according to the rules given, he found that they checked closely.

A discussion over the use of small return pipes from radiators brought out the point that while they might be correct from a theoretical standpoint, they are likely to become bent by being stepped on, also where the return is run under a floor with a cinder fill, a small pipe may easily become trapped, a condition which may cause considerable trouble. For these reasons it was stated that pipe less than 1 in. in diameter should not be used, although M. S. Cooley placed the minimum at ¾-in. pipe.

Second Session, Thursday Evening.

The first paper of the evening session was on "Establishment of a Standard of Transmission Losses from Building of of all Constructions," by Reginald Pelham Bolton. This paper was also part of the educational committee's report presented before the National District Heating Association and was published in THE HEATING AND VENTILATING MAGAZINE for July, 1915. The figures given in Mr. Bolton's tests showing the high temperatures of the wall directly behind a radiator placed close to the wall, brought out a statement from Mr. Cooley that experiments had shown the advantage of placing insulation against the wall directly back of radiators to prevent undue heat absorption by the wall.

A paper was then read on "Engineering Data for Designing Furnace Heating Systems," by Prof. A. C. Willard. One of the most significant statements made in this paper was that "water pans or humidifiers of the positive type only, with direct heating surface should be installed, and should have an evaporative capacity sufficient to maintain a relative humidity from 40 to 50% at 70° F., when the air enters at 32° F. and 25% saturated. Such pans or tanks must have an automatic feed under ball cock control in order to be effective. When the outside temperature approaches zero the interior humidity must be reduced to 40% or less to avoid condensation on cold surfaces."

The question was asked, during the discussion, whether any warm air furnace now on the market is equipped to give this amount of humidity at the temperature stated, and it was brought out that none of the humidifying appliances used with warm air furnaces can supply such an amount of humidity.

The difficulty of securing proper results with narrow air flues was pointed out by Frank K. Chew who stated that the proper proportioning of such flues was one of the prime requisites of good furnace heating design.

The next paper was on "Experiment in Ventilating a School Room." This was part of the report of the Chicago Ventilation Commission which was reviewed in THE HEATING AND VENTILATING MAGAZINE for May, 1915. The results of the experiments in this particular room were previously published in THE HEATING AND VENTILATING MAGAZINE for December, 1913. The room was especially fitted up, containing an air-tight false-floor built about 18 ins. above the regular floor of the room, while a false ceiling was hung about 8 ins. below the room ceiling. Tests were then made under varying conditions of air supply and removal.

In the discussion of this paper, J. D. Cassell stated that in the Philadelphia schools it is the customary practice to place direct radiators under windows, the wall directly back of the radiators being lined with a non-conducting covering.

President D. D. Kimball told some of the recent experiments conducted by the

New York State Commission on Ventilation in Public School 51 in the Bronx. There, he said, difficulties were found in securing devices that would show both slight vertical and slight horizontal movements of air. Strips of tissue paper attached to sticks were useful in determining lateral air currents but would not be affected by slight vertical currents. By arranging the tissue paper so that it presented slanting sides, it was now possible to measure both vertical and lateral currents. He said the slight movement of the paper would indicate almost ideal diffusion but that such diffusion was not found to be accompanied by ideal ventilation.

Topic No. 1 was then taken up: "Do the general names of 'air line return system' and 'vacuum return system' best distinguish the modern type steam systems from the common one and two-pipe systems?"

(A discussion of this topic will be found on another page of this issue.)

In discussing this topic Mr. M. S. Cooley said that one name such as "air return system," to distinguish all systems in which the air is removed through the returns is sufficient. The use of the word "vacuum," he added, makes it hard to tell where to limit such systems, as many systems claim a vacuum which use no pumps whatever, but depend on condensation in the radiators to produce a temporary vacuum.

Topic No. 2: "How long can vapor-vacuum heating systems be operated as closed systems without air binding?"

Mr. Cooley: This depends on the conditions under which the system is closed. If closed when the rate of combustion is less than required to supply all radiation in use, the system will be under a partial vacuum and the length of time it will take to become air bound depends on the tightness of the system, as air will tend to leak in through every joint. If the system is closed under pressure and some parts of it contain air, this air will remain until the vent is again opened, as no air can get out except by leakage. Such leakage will be much less than under a vacuum, as the difference in pressure will not be over 2 or 3 lbs., while we may have a difference of 8 or 9 lbs. with a vacuum.

Topic No. 3: "If operated as an open system, should the sizes of supply piping and radiation be larger than required for 1 to 5 lb. pressure systems?"

Mr. Cooley: I cannot say that they should not be larger than required for higher pressure, but they certainly do not need to be as large as are ordinarily used for such systems.

Topic No. 4: "In the open system should the drop in pressure in supply mains due to friction and condensation be considered in deciding the static head required to return the water to boiler against pressure?"

Mr. Cooley: I see no reason why such friction has any effect on the static head as the entire system including radiators and piping beyond the supply valve to the radiators is under atmospheric pressure and the static head must be suffiicent to cause the water in the return pipe which is under atmospheric pressure, to enter the boiler against the pressure therein. Of course, the loss of pressure in the mains must be considered in determining the boiler pressure necessary to supply steam to the radiators and may thus affect the head indirectly, if you look at it that way.

Third Session, Friday Afternoon.

A paper on "Measurement of Air Flow," by Arthur K. Ohmes was presented at the opening of the afternoon session on Friday. This was an elaboration of an address delivered by Mr. Ohmes before the New York Chapter of the society last winter. Early methods of air measurement were shown, showing the development of such methods from their inception. The various classes of air measuring instruments were taken up at length.

Mr. Ohmes' paper was discussed by Dr. E. V. Hill, who wrote that the paper was very well written and a valuable contribution to the society, and added:

"He discusses methods of making air measurements in a manner so complete and scientific that it makes me feel that I have yet much to learn regarding this important subject. I did not even know that there was such a thing as a frictionless anemometer and shall endeavor to obtain one if possible.

"He describes the A. B. C. tube as the standard in this country. While I feel that the American Blower Co. is entitled to the credit of introducing and standardizing this tube, still it will be remembered that our society has adopted a tube varying slightly from the specifications of the A. B. C. tube which we had hoped to make the standard.

"Mr. Ohmes' evolution of his formula is very plainly worked out but it appears to me that inasmuch as most of our engineering books give the weight of air in pounds per cubic foot, and also inasmuch as our anemometer readings and specifications on plans call for velocities in feet per minute the formula

$$v=1096.5\sqrt{\frac{P}{W}}$$

is in better shape for our use than the one suggested by Mr. Ohmes. You will note from Mr. Ohmes' formula v is in feet per second while ours is in feet per minute. I have rearranged the formula slightly, squaring the constant 1096.5 and placing it beneath the radical and from this plotted a curve for determining directly the velocity from any combination of P and W that comes within the range of ordinary practice.

"I am making some experiments at the present time in reading the variations of water column in a finely graduated tube by means of a Leitz micrometer eye piece used in microscopic work. This is arranged with a micrometer screw and vernier and variations in the column up to 1/1000 in. can be easily determined. The difficulty in these experiments has not been in measuring the variations in the column, but rather in getting a column that is quiet enough to measure. It is possible that a tube may be devised on which a certain velocity reading can be taken and the air current shut off, allowing the water column to become stationary and the difference read in this manner. This would give us a method of reading variations accurately to 1/1000 in. or even less.

"Regarding the use of Venturi meters and throttling nozzles, I have felt that the Chicago chapter should take up some experimental work along these lines, as it appears that an instrument could be devised for making use of this principle."

Arthur T. Ritter stated that the A. B. C. tube does not differ in any material degree from that proposed by the society.

The next paper was on "Determination of Pipe Sizes for Hot Water Heating," by Prof. F. E. Giesecke. This was a lengthy discussion of the Rietschel system of hot water heating and Prof. Giesecke's presentation was highly commended by Arthur K. Ohmes who sent in a written discussion of the paper. The paper included the application of this system in the academic building of the Agricultural and Mechanical College of Texas which was illustrated with plans of the layout. Numerous velocity and friction curves were also incorporated in the paper.

Prof. J. D. Hoffman contributed the next paper which was on "Apparatus for the Study of Heat Radiation" (This paper is published in full on another page).

Before the final paper on the program was taken up a break was made to consider the report of the committee that formulated the resolution providing for a lecture course on heating and ventilating, to be conducted by the society. The report aroused a lengthy discussion.

One point brought out was that the colleges and universities which have been approached with the idea of establishing a heating and ventilating course have mostly refused to do so on the ground that the art is not of sufficient importance to warrant a degree. It was shown that if the society waited for the colleges to inaugurate a suitable course it would be a long time in coming. As to those colleges which now have heating and ventilating courses, it was felt that where they are developed and conducted by any one man, the courses are apt to reflect the prejudices and individual opinions of the man in charge.

On the other hand, if a course were prepared by the society, the different phases of the subject could be prepared by experts in that particular line, with the result that the completed course would constitute a curriculum that would be superior to anything that the colleges had to offer.

There were some expressions on the

other side of the subject the view being taken by several that the society was going somewhat out of its field to inaugurate a course of study in heating and ventilating and that the practical difficulties in carrying out the idea would prove to be insurmountable.

The committee that was appointed will take advantage of the interval between now and the time of the annual meeting to make a full investigation of the possibilities in conection with the course and report at the annual meeting.

The final paper on the programme was then presented being entitled, "Can We Locate the Neutral Zone in Heated Buildings?" by J. J. Blackmore. Among those who discussed this paper was W. H. Driscoll who gave it as his opinion that in the case of a large building divided up into offices there would be a number of neutral zones, all at different levels. Mr. Driscoll gave an interesting review of the difficulties experienced in connection with heating the drug store at the northwest corner of the Hotel McAlpin in New York. In this store a rear door opened onto the lobby of the hotel and on account of the indraft from the street into the store it was necessary to add about one-third to the amount of radiation originally calculated for this store.

As the hour was growing late the remaining topics for discussion were held over until next January and the meeting thereupon adjourned.

Convention Notes.

During both days of the meeting chair rides were provided for the ladies, while tickets for the Steel Pier were available to those wishing to hear the band concerts and other attractions on this pier.

With each morning free a number of bathing parties were arranged, the warm weather making the sea especially attractive.

The dinner and dance Friday evening were omitted. Friday evening was the warmest of the meeting and the members and guests were well satisfied to enjoy the pleasures of the Boardwalk and ocean breezes.

The following were registered:

MEMBERS AND GUESTS PRESENT.

D. D. Kimball, New York.
Homer Addams, New York.
J. J. Blackmore, New York.
James T. J. Mellon, Philadelphia.
Maxwell S. Cooley, Washington, D. C.
G. W. Barr, Philadelphia.
E. E. McNair, Detroit.
W. G. R. Braemer, Camden, N. J.
J. D. Cassell, Philadelphia.
F. E. W. Beebe, New York.
Bert C. Davis, Elmira, N. Y.
G. B. Nichols, Albany, N. Y.
E. C. Wiley, Lynchburg, Va.
A. E. Hall, Albany, N. Y.
John Morton, New York.
H. R. Dillon, Chicago.
B. H. Davis, Philadelphia.
H. R. Wetherell, Peoria, Ill.
B. K. Strader, New York.
James A. Donnelly, New York.
P. H. Seward, New York.
E. K. Lanning, Camden, N. J.
E. T. Murphy, Philadelphia.
S. A. Jellett, Philadelphia.
A. P. Goldsmith, Philadelphia.
Charles R. Bishop, Lockport, N. Y.
Walter J. Kline, Lockport, N. Y.
A. E. Carpenter, New York.
S. Morgan Bushnell, Chicago.
D. L. Gaskill, Greenville, O.
M. W. Franklin, East Orange, N. J.
Nels T. Sellman, New York.
Oscar Fogg, New York.
Louis P. Monash, New York.
Arthur Ritter, New York.
Frank P. Keeney, Chicago.
Samuel L. Greason, New York.
J. F. McIntire, Detroit.
S. E. Plews, Philadelphia.
H. R. Watson, New York.
W. H. Timm, Philadelphia.
A. S. Mappett, Philadelphia.
Henry G. Issertell, New York.
T. H. Hill, Cleveland.
J. I. Lyle, New York.
H. H. Hellermann, Philadelphia.
A. S. Armagnac, New York.
G. W. Martin, New York.
Frank K. Chew, New York.
Maxwell F. Gilbert, Philadelphia.
George Boon, Philadelphia.
E. I. Hetherington, Philadelphia.
W. S. Moffit, Staunton, Va.
H. D. Bristol, New York.
Frank Shay, Newark, N. J.
H. W. Pfeffer, Philadelphia.
G. Petersen, New York.
H. C. Beatty, Philadelphia.
W. H. Driscoll, Jersey City, N. J.
J. F. McElfalrich, Buffalo.
Robert R. Jones, Harrisburg, Va.
C. L. Riley, Plainfield, N. J.
W. E. Tinker, Philadelphia.
C. C. Winterstein, Philadelphia.
E. F. Kingsbury, Philadelphia.
D. S. Boyden, Boston.
W. J. Marshall, New York.
Mrs. B. K. Strader.
Mrs. E. T. Murphy.
Mrs. A. E. Carpenter.
Mrs. T. H. Hill.
Mrs. J. I. Lyle.
Mrs. H. H. Hellerman.
Mrs. A. S. Armagnac.
Master Alden P. Armagnac.
Miss Emily D. Packard.
Mrs. Frank K. Chew.
Master Frank K. Chew, Jr.
Mrs. Homer Addams.
Mrs. Champlain L. Riley.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter.

Arrangements have been made to hold the opening meeting for the season of the New York Chapter at Keen's Chop House, 70 West 26th Street, New York, Monday, October 18. Following a chapter dinner, the members will be addressed by Rawson Vaile of the American Blower Company on "Export Engineering" and by R. D. Hopkins on "Engineering Work in China." Mr. Hopkins has spent several years in China on engineering work for the Chinese government.

Illinois Chapter.

The annual meeting of the Illinois Chapter was scheduled to take place Monday, October 11, in the New Morrison Hotel, Chicago. The principal business was the election of new officers.

Increase in Membership.

Efforts to increase the membership of the American Society of Heating and Ventilating Engineers have resulted in an addition of 110 new members during the present year, up to July 1.

British Heating Engineers.

The accompanying group photograph of the heating engineers present at the midsummer meeting of the Institution of Heating and Ventilating Engineers at Leamington, England, June 22, will be of interest in showing the faces of many of the members who are known only by name to most American engineers. The president of the Institution, H. H. Grundy, is shown seated in the center of the second row. Secretary W. G. Hollinworth is shown standing in the back row at the left of the picture. The second and third figures in the second row at the left are G. Crispin and E. Hering.

Turning to the right of the photograph, W. Yates is shown third from the end in the back row. Standing next to Mr. Yates on the left is S. Naylor who has been spoken of as in line for higher honors in the Institution.

International Engineering Congress.

The program for the general sessions of the International Engineering Congress, held in San Francisco, September 20-25, included a session on heating and ventilation. An introductory paper was presented by Prof. R. C. Carpenter, of Cornell University, describing recent advances in the heating and ventilating field. This was followed by a paper on "Recent Developments in Heating and Ventilation Art," by D. D. Kimball, president of the American Society of Heating and Ventilating Engineers, and another on "Vacuum, Vacuo-Vapor and Atmospheric Heating Systems," by Prof. J. D. Hoffman, of the University of Nebraska.

Among the papers to be presented at other sessions are the following: "The Struggle Against Dust," by C. C. Dassen, inspector-general of streets in Buenos Aires; "Power Plant Design," by H. S. Putnam, of New York; "The Boiler of 1915," by Arthur D. Pratt, of the Babcock & Wilcox Co., New York; "Pulverized Coal in Reverberatory Furnaces," by D. H. Browne; and "Burning Pulverized Coal in

BRITISH HEATING ENGINEERS AT LEAMINGTON, ENGLAND.

Copper Reverberatories," by E. P. Mathewson, of Anaconda, Mont.

The congress is calling renewed attention to the fact that membership in the congress is open to all. The fee is $5.00, which includes, without extra charge, the index volume and any one other volume. Vol. II, entitled "Miscellaneous," will contain the papers and discussions on heating and ventilation. The headquarters of the congress are in the Foxcroft Building, San Francisco, Cal.

NATIONAL DISTRICT HEATING ASSOCIATION

Arrangements for Next Annual Meeting.

The selection of New York City as the place for holding the next annual meeting of the National District Heating Association was one of the important actions taken by the executive committee of that association at its fall meeting in Atlantic City, September 16-18. Headquarters will be at the Hotel Martinique. The committee was represented by President David S. Boyden, Secretary D. L. Gaskill, H. R. Wetherell and George W. Martin.

It was decided to have an exhibit during the convention; also to have a four days' convention, the dates fixed being May 23, 24, 25 and 26, 1916. The program as arranged for contemplates four papers, seven reports of the standing committees and three addresses. It was also decided to hold the annual banquet Thursday evening, May 25.

Some of the subjects which will be considered in papers and addresses are as follows: "District Heating and Its Relation to Electric Utilities Operation"; "Appraisals of Utility Property"; "Ratio of Economizing Coils of the Different Types of Heating Systems"; report of delegates to the Pan-American Congress; report of Station Operating Committee; report of Educational Committee; report of Rate Committee; report of Record Committee; report of Public Policy Committee; report of Underground Construction Committee.

The resignation of William S. Monroe, of Chicago, as a member of the executive committee was received, as he found it to be impossible to perform his duties owing to his work in that city.

It was decided to submit an amendment to the constitution reducing the publication committee from five to three members and making the publication committee consist of the president, past-president and the secretary. It was also decided to approve constitutional authority for filling a vacancy on the executive committee.

The convention committee selected to take charge of the arrangements for the convention in New York is: George W. Martin, of the New York Service Company; Charles A. Gillham, of the New York Steam Company, and E. F. Tweedy, of the New York Edison Company.

It was also decided to assign four persons to discuss each paper and report of the standing committees presented to the convention, such assignment to be made in advance of the convention and copies of papers and reports to be furnished such persons so selected.

Reports of the work of the association showed it to be in a splendid condition both financially and in number of members.

Varying Views on the Proposed Standard Title for Return Line Systems.

A canvass of some of the principal manufacturers of vacuum and vapor heating systems regarding the proposal to adopt the name, "Air Return Line Systems," as a general classification for many of the vapor and vacuum heating systems now on the market, was made recently by The Metal Worker. The name "air return systems" was intended to be a general descriptive title for heating systems now known by various names, such as "atmospheric," "modulation," "thermograde," "fractional," "vapor" and "vacuum." The point was made that it would then be easy to differentiate the various systems by adding the particular trade name, such as "atmospheric air return system," and "modulation air return system," etc.

One manufacturer expressed the opinion that the proposed name would not accomplish the desired result as it does not make a distinction between the closed and open special systems. He also stated that he does not believe it would be well to attempt to cover both open and closed air return line systems under one head.

Another manufacturer, Reuben N. Trane, of Trane Co., favored some other title than air return line systems as these are generally known as having an air valve and a small return line back to the boiler or vacuum pump. He suggested the name, "special heating system."

Bishop-Babcock-Becker Company did not consider the proposed title advisable for the reason that there is a distinction between the system where the air is only pumped out of the radiators by means of a vacuum pump and the system where both the air and condensation are pumped or

drawn through a return line. This, they held, also applies to the vapor system where no pump is used and in which the air is forced out through return condensation lines and a check valve provided to prevent re-entry of air. This company expressed the opinion that the three systems really call for three distinctive names.

While endorsing the idea of using one general name, the American District Steam Company does not favor the adoption of any name that will eliminate the company's term "Atmospheric," as this would tend to eliminate the individuality of the company's system. With that exception the company stated that the name of "air return line system" appears to be very logical.

Full endorsement of the proposed name was given by the Chicago Pump Co., the Roys Heat Control Co., of Brooklyn, N. Y., and the Vacuum Heating Co., of Philadelphia.

The C. A. Dunham Company objected to the use of the particular name suggested on the ground that air return leaves out the essential feature of all later day heating systems, as they are not only air return systems, but air and water return systems. It was suggested that a better name would be "return line systems," leaving off both the words "water" and "air." Return line could refer to either water or air or both and in that way take into account all specially advertised systems of heating.

A Heating Engineer on Subway Ventilation.

An exhaustive history of New York subway ventilation and a proposed remedy for the existing conditions are contained in an illustrated brochure on the subject which has been compiled by James G. Dudley, consulting engineer, New York. The author commences by calling attention to the present lack of ventilation in the New York subway, as understood in modern engineering circles. An illustration of the original design of this subway shows that no provision was made for ventilation by those responsible for the design. When the first warm weather came, the engineers described the conditions as "unexpected," and indicated that they expected the subway to ventilate itself.

It is brought out that 85% of all the energy generated at the power stations of the subway is dissipated in the form of heat inside the subway itself in various ways.

The first alteration in the New York subway was the punching of holes in the covering to permit the escape of the heated air. However, as no draft was provided, this failed to solve the problem. In addition to this, an effort was made to cool the subway air through the use of air washers, the air being recirculated through the washers by blowers. A well, driven to a considerable depth, furnished the cold water used. This, owing to the lack of capacity when the cubic contents of the subway are considered, did little or nothing to relieve the situation.

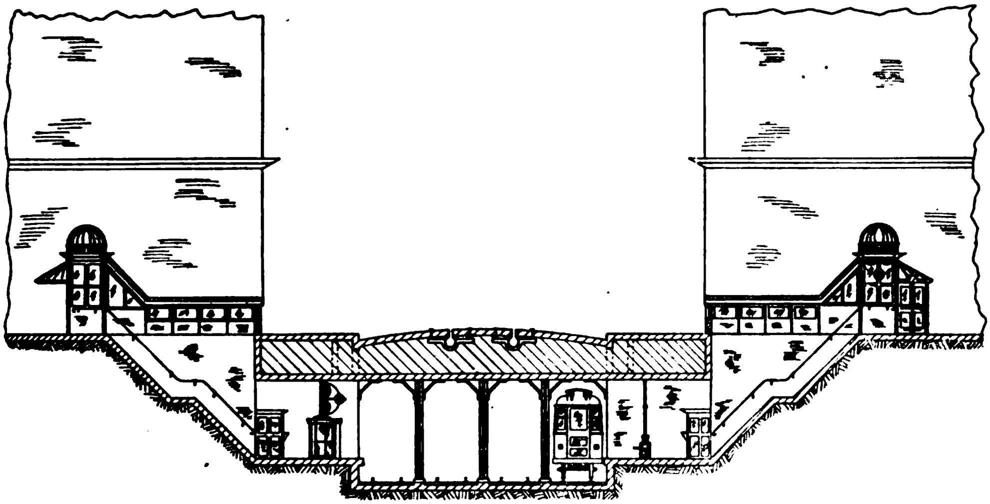
Later on there were installed at various points in connection with the roof openings some 25 blowers, each of which was capable of exhausting 1,000,000 cu. ft. of air per minute. This, according to the chief engineer, afforded some relief.

The next change was the construction of vent chambers between stations at the sides of the subway, being an attempt to control the inflow and outflow of the subway air by the piston-like action of the trains. Louvres were hung in an ingenious manner in the side wall of the subway. The flaps were intended to open as the trains passed and close immediately thereafter, the suction thus created drawing in fresh air at the stations.

Mr. Dudley states that the trains do not act as pistons within a cylinder as the tracks are not separately sealed. During the last few years it is stated that there appears to have been no further attempts to ventilate the subway, except that "agitator" fans were installed in the cars themselves.

When the new dual system of subways was started, in 1913, the plans of the engineeds provided for the cutting of holes in the sidewalks along the route of the subway and adjacent to the retail stores. Blowers were to be installed in these vent chambers to discharge the air from the subway. Our readers are familiar with the protests that were evoked by this plan. Mr. Dudley emphasizes the fact that there is omitted entirely any control of the points of admission of the air drawn in as a result of the action of the fans which, he says, will result in short-circuits of air, to say nothing of the objections of dusty air being expelled through the street openings.

The author then discusses the various plans that have been proposed by outside parties, some of which were illustrated and described in THE HEATING AND VENTILATING MAGAZINE for August, 1915. An additional scheme, described by Mr. Dudley, is that proposed by Henry G. Opdycke, engineer for the Broadway Association. This



DUDLEY "SECTIONALIZED" SYSTEM OF SUBWAY VENTILATION.

scheme contemplates cutting ducts through the side walls of the subway into and through the basements of abutting properties at intervals along both sides of the subway, and then erecting on private property chimneys extending well above the roofs of the surrounding buildings and discharging therefrom air from the subway by means of large blowers with powerful electric motors placed at the entrance of the ducts or at the base of the chimneys referred to.

After showing the plan suggested by George Hallam Clark (published in THE HEATING AND VENTILATING MAGAZINE for May, 1915), Mr. Dudley proceeds with a lengthy presentation of the Dudley "sectionalized" system of subway which he has designed (also described in THE HEATING AND VENTILATING MAGAZINE for August, but shown in the circular in considerably fuller detail). Mr. Dudley's design is based on the following fundamental contentions:

1. Adequate mechanical ventilation of any subway is absolutely essential to the safety and comfort of passengers and incidentally attracts traffic and insures profit.

2. Subways elsewhere are adequately ventilated by means of mechanical, that is fan, methods.

3. The subways of New York City never have been, and are not now, adequately ventilated, either on the score of passenger safety, comfort or profits.

4. The subways can be adequately ventilated by means of fans driven by electric motors taking current from a source or power other than that for train propulsion.

5. The problem of mechanically ventilating all the subways in New York is wholly a question of which one of the many plans proposed for so ventilating the subways shall be adopted.

Would Divide Subway Into Sections.

As will be seen from a reference to the Dudley scheme, it is proposed to divide the subway into sections, each of which will have a separate ventilating installation. A typical section will have, say, four electric fans at the various entrances and, in addition, "air-locking" doors will be provided to prevent the ingress or egress of air through the regular passenger entrances. In that portion of the present subway between the Battery and 96th Street a total of twenty installations would be needed, including 100 54-in. fans exhausting a total of 2,700,000 cu. ft. of air per minute. If these fans consumed 10 H.P. each, there would be required a total of 1,000 H.P. hourly to ventilate this assumed portion of the subway. If operated 20 hours daily for 200 days in the year, and if the cost of electricity be taken at 1c. per horsepower-hour the total annual cost would be $40,000. Of course, with this system the present sidewalk gratings and other such intentional or chance openings would be sealed or otherwise done away with.

Mr. Dudley concludes with the interesting statement that the subways of New York, when completed, will, it is estimated, comprise more than 240 miles of track and will have cost more than $250,000,000 and will carry more than 2,000,000,000 passengers per annum.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

52—Overcoming Back Pressure in Heating Systems.

QUESTION: The statement has frequently been made that if an engine exhausts to the atmosphere against 2 lbs. back pressure, by increasing the initial boiler pressure to 5 lbs., a back pressure of 5 lbs. due to the heating system, could be overcome without any additional cost or reduction in power obtained. Is this correct?

ANSWER: No, this is not so. The additional heat per pound of steam is very little in B. T. U., but the steam is denser at the higher pressures, requiring a greater weight for cubic foot. The increase in initial pressure is always much greater than the back pressure to maintain the same mean effective pressure.

There are four ways of overcoming back pressure to obtain the same power load or indicated horse power:

1. By increasing the initial pressure with the same cut-off.
2. By lengthening the cut-off, with the same initial pressure.
3. A combination of the above methods.
4. By increasing the revolutions of the engine.

The last method is usually out of the question, due to the fact that constant speeds are generally obligatory, especially if operating electrical machinery. If the back pressure is too great the engine speed and capacity will be reduced and will require an increase in the initial pressure. The engine overload is generally indicated by a reduction in speed.

In the following discussion the additional cost of lengthening the cut-off will be deduced. Also the cost due to raising the initial pressure sufficiently to overcome the back pressure in the heating system. If an engine exhausts to atmosphere, with a back pressure of more than 16 lbs. absolute or 1 lb. above atmosphere, there is something inherently wrong with the piping or valve setting.

The amount of increase will be calculated for 5 lbs. back pressure or 20 lbs. absolute and 10 lbs. back pressure or 25 lbs. absolute. The engine exhaust will be figured with 16 lbs. absolute, when open to the atmosphere.

In this discussion it is unnecessary to consider the area of the cylinder, length of stroke or number of revolutions, as these will be constant for all conditions under consideration for the same indicated horse power. It therefore becomes necessary to calculate the number of expansions, which is dependent on the clearance and cut-off. The cut-off is the reciprocal of the number of expansions. The mean effective pressure, due to the cut-off and back pressure, must also be determined.

The mean effective pressure is calculated by adding 1 to the Naperian log of the number of expansions and dividing by the number of expansions. The quotient, multiplied by the initial absolute pressure is the mean effective pressure. The clearance will be assumed at 0.05 of the stroke and the cut-off at 0.25 for the load under consideration.

The true number of expansions will be

$$\frac{1 + \%\ \text{clearance}}{\text{Cut-off} + \%\ \text{clearance}} = \text{true number of expansions.}$$

A mean effective pressure will be calculated for 100 lbs. gauge, or 115 lbs. absolute, initial, with 16 lbs. absolute back pressure for the engine exhausting to atmosphere.

The number of expansions for 0.25 cut-off is 4. The true number of expansions, involving the clearance, will be $(1+0.05) \div (0.25 + 0.05) = 3.5$. $[(1 + \text{Log. e } 3.5) \div 3.5 \times 115 \text{ lbs.}] - 16 \text{ lbs.}) = 58$ lbs. M. E. P. $(1 + \text{Log. e } 3.5) \div 3.5 = 0.6437$.

The initial pressure will have to be raised as follows for a back pressure of 20 lbs. absolute to still give 58 lbs. net M. E. P.: $58 + 20 = 78$ lbs. M.E.P. to overcome back pressure 20 lbs. The factor, due to the number of expansions, which will remain the same, is 0.6437. $78 \div 0.6437 = 121$ lbs. absolute, or 106 lbs. gauge, to overcome 5 lbs. gauge back pressure, or 6 lbs.

have to be added to overcome an additional 4 lbs. back pressure, or 50% more than the back pressure.

If a back pressure of 25 lbs. absolute was required the initial pressure would be 58 + 25 = 83 lbs. M.E.P. to overcome 10 lbs. gauge back pressure. 83 ÷ 0.6437 = 129 lbs. absolute for 10 lbs. back pressure or 114 lbs. gauge.

The increase is 14 lbs. pressure for an increase of 9 lbs. in back pressure over atmospheric exhaust.

If the feed water is 210° F., the increase in heat per pound of steam for the different pressures will be as follows:

Total heat steam at 129 lbs. absolute	1,190.8
Total heat liquid at 210° F.	178
Heat required per pound of steam at lbs in B.T.U.	1,012
Total heat of steam at 121 lbs. absolute	1,189.6
Total heat liquid at 210° F.	178
Heat required per pound of steam at 121 lbs. absolute in B.T.U.	1,011.6
Total heat in steam at 115 lbs. absolute	1,189
Heat in liquid at 210° F.	178
Heat required per pound of steam at 115 lbs. absolute in B.T.U.	1,011

It is readily seen that the increase in heat per pound is less than 0.1 of 1% for the greatest increase in pressure and it is probably for this reason that the statement is made that the cost of raising the pressure to overcome the heating back pressure is negligible. This is so per pound of steam, but not per cubic foot. As the reciprocating engine operates on volumes and the volume decreases rapidly for an increase in pressure, the higher initial pressure will require a greater weight of steam for the same volume.

The increase in steam will be as follows:

Weight per cubic foot of steam at 129 lbs. absolute	0.2875
Weight per cubic foot of steam at 115 lbs. absolute	0.2577
Difference for same volume, per cubic foot	0.0298
Weight per cubic foot steam at 121 lbs. absolute	0.2705
Weight per cubic foot of steam at 115 lbs. absolute	0.2577
Difference for same volume, per cubic foot	0.0128

The increase in steam consumption for 16 lbs. back pressure is 289 ÷ 2577 = 16%.

The increase in steam for 16 lbs. back pressure over atmospheric, for the conditions named, is 298÷2577=11.6% increase.

If the cut-off on the engine is varied to overcome the back pressure, due to heating, with the same initial pressure, with 115 lbs. absolute the ratio of expansion will be as follows:

With the same initial pressure and the same net M.E.P. pressure, the factor changes from 0.6437. To obtain the new factor for 78 lbs. gross M.E.P., divide 115 into 78, which equals 0.6782, instead of 0.6437. By trial and error we find that Log. e of 3.18 + 1, divided by 3.18, gives 0.6782 or (1 + 1.1569) ÷ 3.18 = (0.6782×115)— 20 = 58 M.E.P.

The cut-off, without clearance, will be

$$x = \frac{1.05 - (3.18 \times 0.05)}{3.18} = 0.28$$ instead of 0.25 at atmospheric.

The actual increase in steam will be as the ratios of expansion or 3.5 ÷ 3.18 = 110% or 10% increase in steam. If the back pressure is 10 lbs. gauge, instead of 5 lbs., the total M.E.P. will be 58 + 25 = 83 gross M.E.P. The factor will be as before 83 ÷ 115 = 0.7217. Log. e + 1, divided by 2.82 will give factor 0.7217. The cut-off, without the 5% clearance will be:

$$x = \frac{1.05 - (2.82 \times 0.05)}{2.82} = 0.323,$$ or about one-third stroke.

The increase in steam consumption will be, as before, 3.5 ÷ 2.82 = 1.24, or about 25% for increasing the cut-off to provide for 10 lbs. gauge back pressure.

The foregoing shows that exhaust steam heating is not obtained for nothing, although the most economical method is to raise the initial pressure. Five lbs. by the first method requires 5% increase and, by increasing the cut-off, 10% increase.

Ten lbs. by increasing initial pressure 11.6%, and, by lengthening the cut-off, 25%.

In most cases the variable back pressure required to meet outside heating conditions would make varying the boiler pressure inconvenient. The boiler pressure is carried nearly constant and the varying back pressure met by the cut-off which would give the expense due to the varying cut-off.

If the engine is not too lightly loaded the higher steam pressure would reduce the cut-off and make for greater economy when exhausting to atmosphere. There are times when the heating system will require the extra steam, due to higher back pressure, but the increased cost of power should be charged to the heating.

There are many non-condensing plants

furnishing lighting with district heating systems where the heating system requires only about 2 lbs. of coal per kilowatt in addition to the power load and the district heating advocates can show good results. Many of these plants are being reduced to sub-stations for high tension lines from a turbine condensing plant located at a distance.

If the heating and power required 10 lbs. of coal per kilowatt hour and power alone 8 lbs. per kilowatt hour of current produced and the engine on the local plant were only operated on the heating, the cost of heating would increase about four times and practically live steam prices for consumers would have to be obtained to make the heating plant pay.

The writer has one case of this kind in mind where 10 lbs. of coal were used for heating and power and 8 lbs. for current alone, and current is now delivered at less than 3 lbs. per kilowatt hour. This means that the entire up-keep of the heating plant, including engines, boilers, firemen, and engineers has to be charged to heating and the cost of fuel charged to heating is 7 lbs. as against 2 lbs. or 3½ times what it was before the high tension line was installed.

There is one way of meeting this new condition and that is by the use of hot water, where possible, on condensing turbines that can be operated under vacuum with fair economy at all times. As turbines and plant machinery become more economical in operation, the nearer the district heating plant will be to a live steam proposition with the entire equipment charged to the heating. Correspondingly higher rates will have to be obtained, however, to meet the new conditions.

This condition in time will possibly change the by-product steam plants into high pressure steam plants with no power. The extra capacity and reduction in relative condensation losses as compared with those at lower pressures may make up in a measure for the advantages of the modern condensing equipment over the by-product plant when non-condensing.

The increased revenue due to the greater capacity at higher pressures will decrease the proportionate charge for interest and depreciation on underground mains.

New Revised and Enlarged Edition of "Mechanical Equipment of Federal Buildings," Ready November 1.

A revised, rewritten and enlarged edition is announced of Nelson S. Thompson's "Mechanical Equipment of Federal Buildings." Over 100 pages of new reading matter have been added, making practically a new treatment of this important work. The book as revised by Mr. Thompson, who is chief mechanical and electrical engineer in the office of the Supervising Architect, Treasury Department, Washington, D. C., contains all of the basic data used in the design of mechanical equipments of Federal buildings under the control of the Treasury Department. In this third edition this matter has been revised, amplified and extended to include two especially valuable chapters, one on "Operating Data of the Larger Federal Buildings" and another on "Small Refrigerated Drinking Water Plants." The data given for estimating the cost of the mechanical equipment of Federal buildings have also been extended and brought up to date.

The book in its new form will make a wider appeal to heating engineers and contractors, as well as to architects and practical engineers, on account of the fact that the information has been digested and is in available form for use by busy men.

The revised edition contains over 400 pages, size, 6 x 9 in.; price, $3.00. Published by the Heating and Ventilating Magazine Co., 1123 Broadway, New York.

Book Reviews.

District Heating, devoted to the development and operation of central station heating and containing, among other things, heating rates in forty representative cities, is the title of a work that adds much to the published data on this subject. The authors are S. Morgan Bushnell and Fred. B. Orr. The first chapters are given over to the history of district heating, with maps showing a number of installations in the larger cities. It will readily be seen in glancing through the book that it is written from the viewpoint of the central station man and also that it gives special prominence to the advantages of low pressure steam heating. Stress is laid by the authors on the point that hot water heating systems are not well adapted to central station heating work, due to the difficulty of selling heat by meter rates. There is, of course, the additional reason of the cost of changing the steam radiation in existing installations to that of the hot water type.

There is not, however, the same objection to a flat rate on a hot water system properly designed as there is with a steam system, inasmuch as the steam system operates at a constant pressure and temperature, while the water system is capable of a wide variation in temperature, with control at the plant. Steam frequently necessitates intermittent operation to keep the expense down,

while water may operate continuously without excessive cost. Another point to remember is that the lower temperatures available on the water system admit of far greater recovery of power in the use of exhaust steam as compared with steam systems at higher back pressures. Due to the use of high tension lines for electric transmission and condensing turbines of large capacity and extremely low steam rate, it may well be asked whether the by-product heating plants are not being placed more and more at a disadvantage. The extra cost of the equipment for the use of exhaust steam and reduction in capacity of the system due to its use will hardly compensate for the saving in the use of exhaust steam over live steam for heating.

Two solutions of the problem suggest themselves. One involves the use of hot water with low temperatures under a partial vacuum, in connection with the large machines; the other, the changing of the exhaust system to a higher pressure live steam system, with the installation of reducing pressure valves and with proper rates for the service. Experience has shown that the live steam system will pay on a rate of 50 cents per 1,000 lbs. of steam or over.

Where electric current is made for 3 lbs. of fuel per kilowatt hour and only 1 kilowatt is recovered from about 10 lbs. to 15 lbs. of fuel used for heating, the cost of maintenance of the engine equipment for obtaining the power in this manner is apt to counterbalance all the extra revenue from the recovered power. On the other hand, where a by-product plant is already in operation at 5 to 20 lbs. back pressure and the pressure is raised to 50 to 80 lbs. with no exhaust steam, the capacity of the mains is doubled and the increase in revenue may make live steam operation more advantageous. The loss in mains in proportion to steam sold will be greatly reduced.

In one of the chapters the advantages and disadvantages of steam and water are set forth as distinctly in favor of steam. It may be mentioned, however, that a saving in the condensation and the use of a vacuum system on a water system may outweigh the advantage of the lower steam pressure. One is a large advantage in operating cost and the other is one of engineering construction simply.

The statement is made in one chapter that hot water heating requires 50% more radiation than steam. If the water is used at the same temperature as the steam, which is quite feasible, this, of course, would not hold. A number of hot water heating plants are operating at 220° to 260° F. in extreme weather. As a rule, however, hot water plants are generally operated at a lower temperature than steam, so as to obtain the advantage of the lower terminal exhaust steam pressure, which is impossible in the ordinary steam system.

In discussing friction losses, the authors state that the friction loss on a hot water system is much greater than on a steam system and that the mechanical work is returned to the system in heat in both cases. This may be questioned. The loss in a hot water system due to pumpage is simply live steam operation if the exhaust is used to heat the water. The loss in radiation in many steam systems operating under 5 lbs. pressure is considerably greater than on a two-pipe water system and the least loss in district heating systems will be on a high pressure live steam system on one pipe. The friction head only should not be taken into consideration, as if the same capacity in heat units is considered the weight in water by the possible drop as against the cubic feet of steam with its volume and latent heat, will give a smaller main for the water for the same B.T.U. capacity.

The chapter on meters is excellent, giving complete descriptions as to methods of construction and theory of operation. Also noteworthy is the coal-purchasing information contained in Chapter V. Size 6 x 9 in. Pp. 290. Price $3.00. Published by the Heating and Ventilating Magazine Co.

POWER, HEATING AND VENTILATION, by Charles L. Hubbard, is a series of three volumes devoted to the design, construction and management of power and heating plants. The volume on "Heating and Ventilating Plants," like the other two, is described as a treatise for students and a reference book for engineers. Without considerable research and trouble it would be difficult to check the many formulas given by the author, as, in most cases, only results are given by substitution in an arbitrary formula. It is, of course, unnecessary to say that the mechanical work of substitution in formulas gives a student little or no knowledge or insight into the reasons for using the factors.

The arrangement of the data is good, though the data, as far as can be observed, are a compilation rather than a new presentation. In his chapter on direct steam heating the author states that water heating requires larger radiators than steam heating. In these days of vapor systems and rapid circulation hot water systems it depends on the conditions, as water or steam may be operated at the same temperature. The radiation is proportioned solely by the temperature of the heating medium.

Though not a matter of importance. it is a little unfortunate that an abridged steam table is presented that is considered by most engineers as out-of-date, since all modern works recognize the Marks and Davis steam tables as standard.

In the chapter on indirect radiation we come to an example of the use of arbitrary formulas. The figuring of indirect radiation by the methods indicated might serve for less important work, but would be liable to lead to error in fan blast work. Pipe sizes for indirect radiation should really be based on pounds of steam rather than on square feet of radiation on account of the varying conditions under which air is used for heating and ventilating.

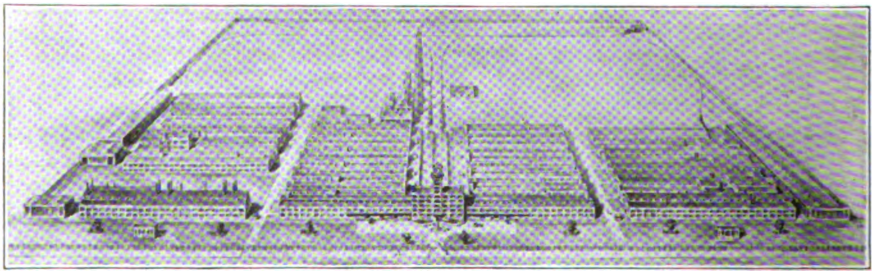
In the chapter on forced hot water circulation we again find arbitrary formulas which might not apply on large work. Size 6 x 9 in. Pp. 308. 207 ills. Price $2.50. Published by the McGraw-Hill Book Co., 239 West 39th Street, New York, and may be had through the book department of THE HEATING AND VENTILATING MAGAZINE.

New Publications.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Vol. VII, 1914, have been published in the name of the Institute by the D. Van Nostrand Co., 25 Park Place, New York, and may be had at $6.00 net. One of the principal papers in this volume is that on "Ozone in Ventilation," by J. C. Olsen and William H. Ulrich. This paper was published in part in THE HEATING AND VENTILATING MAGAZINE for July, 1914. Size 6 x 9 in. Pp. 308.

New Plant of Crane Company.

The accompanying illustration shows the extent of the new $10,000,000 group of factory buildings which will comprise the plant of the Crane Company, at Corwith, Chicago. As stated last month, the new plant will embrace 49 buildings, of steel and reinforced concrete construction, having an aggregate space of 50 acres. One of the typical buildings is a two-story structure, 500 ft. long and 80 ft. wide. The works office building is distinguished by its clock dial which is 15 ft. in diameter, with four faces and illuminated. Hot water under forced circulation will be used to heat the entire plant.



NEW PLANT OF CRANE CO. AT CORWITH, CHICAGO.

NEW DEVICES

Sims Gas Engine Economizer.

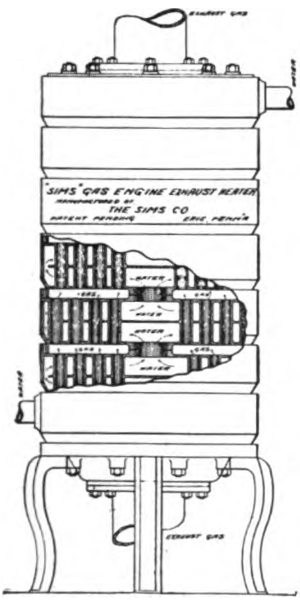
In most plants using gas engine power a boiler is necessary to furnish heat either through the medium of hot water or steam. This boiler must be ready for service whenever heat is required. An installation of a gas engine economizer would result in making use of waste heat in the exhaust gases, using a steam boiler as the water and steam storage. There is also a considerable portion of time in the late spring and early fall when heat is required only during the day and sometimes only in the office portion of a building. At such times the economizer may be able to furnish sufficient steam to take care of the service without any assistance from the boiler. On the other hand, when it is necessary to maintain a fire under the boiler the service obtained from the economizer would keep down to a minimum the amount of fuel required and thus effect a considerable saving.

As a result of these considerations, the Sims Company of Erie, Pa., has placed on the market an interesting apparatus, known as the Sims Gas Engine Economizer. This heater is made entirely of cast iron in round sections. Passages for the exhaust gases are provided in each section of ample area to avoid back pressure on the engine. The sections are built up in number and

size according to the horsepower of the engine in service. In a circular illustrating and describing the heater a number of illustrations are included showing how the economizer may be connected to secure different results.

The company publishes a noteworthy table showing the amount of available heat units that can be converted into hot water or steam, the amount being dependent on the thermal efficiency of the engine:

Thermal efficiency of engine, per cent...	15	20	25
Jacket water, per cent.	50	.40	30
Exhaust gas and radiation, per cent...	35	40	45
	100	100	100



CONSTRUCTION OF SIMS GAS ENGINE ECONOMIZER.

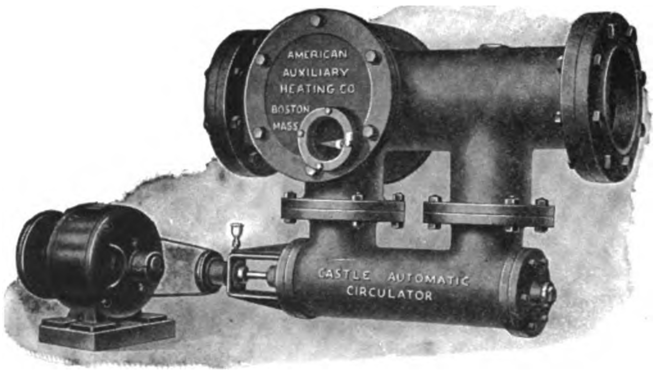
B.T.U. per 1 H.P. per hour	16,967	12,725	10,180
Utilized in engine..	2,545	2,545	2,545
Jacket water	8,483	5,090	3,054
Exhaust gases and radiation	5,939	5,090	4,581

The average amount of steam at 212° F. using exhaust gases only and supplying the boiler with jacket water at 120° is approximately 5 lbs. per horsepower per hour. The average amount of steam at 212° F. using the combined waste heat of jacket and exhaust gases is from 9 to 12 lbs.

When producing steam from both the jacket and exhaust gases, a circulating pump of high efficiency must be used, passing large volumes of water through the jacket to guard against burning the cylinder. The jacket space must also be free of fins and spuds. Engine builders do not recommend producing more than 5 lbs. of steam in an installation of this kind. On account of the variable thermal efficiencies of engines, operating conditions and fuel values, it is impossible to guarantee absolutely the results that can be secured. The amount of heating surface in a Sims economizer is figured to secure the best results on an installation of average thermal efficiencies and at a reasonable cost price.

Castle Circulator.

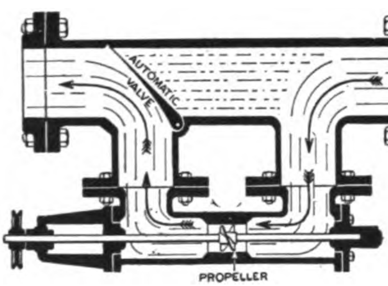
The Castle Circulator, described as a mechanical contrivance operated by means of a motor, gas engine or water power, for the purpose of producing or increasing the velocity of circulation in any kind of a hot water system, has been placed on the market by the Molby Boiler Co., Inc., 39-41 Cortlandt Street, New York. This device acts to produce a positive circulation



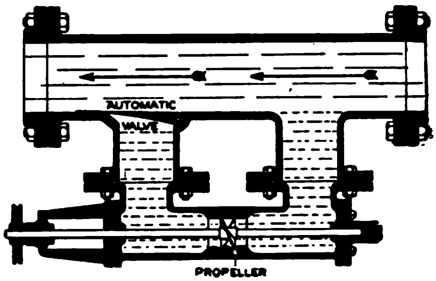
CASTLE AUTOMATIC CIRCULATOR FOR HOT WATER HEATING SYSTEMS.

through the entire plant and is so arranged as not to retard circulation when the power is shut off. It is especially useful in forcing circulation where the mains are so nearly level that they are sluggish, as a gravity main. It will also circulate positively radiation below the level of the heater, where results are often unsatisfactory. Where a radiator is located below the water line of a steam boiler it has been found possible to use this device in circulating the water through such radiator, making it possible to heat a room on the boiler level.

Other points mentioned for the Castle circulator are that it acts as an insurance



Circulator in Operation



Circulator "Cut Out"

CONSTRUCTION AND OPERATION OF CASTLE AUTOMATIC CIRCULATOR.

against freezing, that it produces an even temperature throughout a heating system and reduces the drop in a hot water system through the rapid circulation to 5° to 8°, as against 18° to 30°. In case of sudden drops in temperature, the circulator can be started to take care of the lower temperature without waiting for a slow fire to bring the temperature to the required point.

Another interesting feature is that the circulator does not put extra pressure on the system. Its operating cost is stated to be quite low, while it is estimated that the saving in fuel will soon pay for the cost of the device.

Trade Literature.

MODIFIED SYSTEM FOR ESTIMATING RADIATION, by Carleton F. Tweed, containing practical working rules, with tables, for using the common heat unit method, originally published in *The Practical Engineer,* has been reprinted in circular form by the Dole Valve Company, Chicago. This system includes allowances for such factors as difference in altitude, differences in temperature between the radiator and the room, and differences in the heights and widths of radiators. The use of the system is illustrated in a typical case where it is used to figure the radiation for the first floor as shown in a given plan. Alternate pages of the pamphlet are devoted to illustrated descriptions, together with roughing in dimensions of the Dole packless valves. The statement is made that 250,000 of these valves are now in successful use. Size 9 x 6 in. Pp. 20.

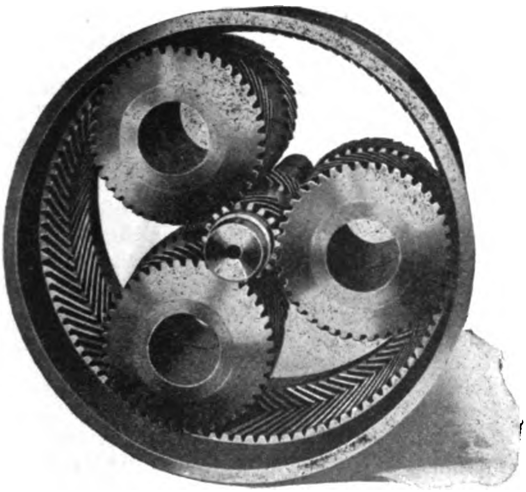
BEACH-RUSS VACUUM PUMPS, designed to satisfactorily meet the requirements for vacuum heating systems, are the subject of new circular matter calling attention to the important features of construction of this pump, which is manufactured by the Beach-Russ Company, 220 Broadway, New York. The pump may be arranged to suit various conditions in connection with return line vacuum heating systems, and the company is prepared to furnish blueprints showing such arrangement. In operation the pump constantly withdraws the condensation and air from the radiators in a building. It also is designed to separate the air from the water and to return the condensation to the boiler under 10 lbs.

BEACH-RUSS VACUUM PUMPS FOR VACUUM HEATING WORK.

pressure, or the condensation can be discharged into a receiving tank and thence into the boiler, as conditions permit. Special attention is called by the manufacturers to the wearing qualities of the Beach-Russ vacuum pumps which are fully guaranteed to perform their duties satisfactorily. A point is also made of the fact that the pump can be applied to either new or old steam heating plants of any capacity, whether supplied from a boiler or from a central station heating plant. The pump

may also be used for heating with exhaust steam from an engine, without back pressure. As the pumps have no intricate parts, there is little to wear out, reducing the repairs to a minimum. The Beach-Russ Company has manufactured vacuum pumps for the past 20 years which is presented as an indication of the company's reliability and knowledge of this field. The company's full line includes also air line vacuum pumps for Paul air line vacuum systems, and water and liquid pumps; several sizes of condensation receivers and complete pump outfits; also thirteen sizes of rotary pressure blowers, which will operate against a head of from 1 to 12 lbs.

THE TURBO-GEAR, for use either as a speed reducing or speed increasing gear, which will run either right or left hand with the same efficiency, is described in a new circular, issued by the Turbo Gear Co., Industrial Building, Baltimore, Md. The driving and the driven shaft of this speed transformer rotate in the same direction. They are being made in seven different standard speed ratios. The manufacturers call especial attention to the adaptability of this gear to high-speed electric motors, whereby the right speed may be obtained without the use of sprockets and chains, pulleys and belts, extra shafting and bearing, etc. It is also sometimes necessary to increase the speed when using steam, gas or oil engines for driving high-speed machines, such as centrifugal pumps, blowers, etc., and it is stated that the turbo-gear is equally efficient in this case.



THE TURBO GEAR. FOR INCREASING OR REDUCING SPEED OF ELECTRIC MOTORS, AND OTHER APPARATUS.

MOREHEAD BACK TO BOILER SYSTEM OF STEAM DRAINAGE AND BOILER FEEDING is a carefully-prepared and attractive catalogue devoted to the Morehead tilting steam traps, return, non-return, vacuum and condenser, manufactured by the Morehead Mfg. Co., Detroit, Mich. The descriptive matter is accompanied by data on typical installations, as indicated on temperature recording charts, showing the fuel savings that have been achieved. There is also much special information, such as an explanation of the necessity for using the Morehead back-to-boiler system even though the boiler is below the heating system, and advantages of the Morehead system on one pipe heating systems. The remainder of the catalogue is devoted to a variety of power plant installations equipped with Morehead traps, accompanied, in many cases, with testimonial letters expressing the satisfaction of Morehead users. Size 6 x 9 in. (standard). Pp. 64.

NATIONAL BULLETIN, No. 20, issued by the National Tube Co., Pittsburgh, contains an index for National Bulletins Nos. 1 to 20. These bulletins, as indicated by the index, contain exhaustive pipe information which is now made readily accessible to the busy man, whether contractor, dealer, or consumer. The last pages of Bulletin No. 20 contain a summary of the preceding bulletins, those of special interest to the heating trade being No. 2 on "Corrosion of Hot Water Piping in Bath Houses," No. 3 on "The Durability of Welded Pipe in Service," No. 6 on "Pipe Threading Dies," No. 10 on "Relative Corrosion of Iron and Steel Pipe as Found in Service," No. 11 on "History, Characteristics and the Advantages of National Pipe," No. 12 on "Characteristics of National Pipe," and No. 80 on "List of Products."

LEA-COURTENAY CENTRIFUGAL PUMPS, made by the Lea-Courtenay Co., Newark, N. J., are presented in an engineering catalogue in which detailed information regarding this type of pump is supplemented by a quantity of data regarding turbine pumps in general and other pump data. The matter is divided into chapters, one chapter being devoted to the "Necessity of an Efficient Testing Plant." Other chapters take up Lea-Courtenay single-stage pumps for low and moderate heads, single-suction multi-stage pumps, balanced pumps and double-suction multi-stage pumps. There is also a chapter on Lea-Courtenay back-to-back pumps for boiler feeding, one on vertical multi-stage pumps, one on underwriters' fire pumps, and a final chapter (Chapter XII) on Lea-Courtenay portable sinking pumps. Size 6 x 9 in. (standard). Pp. 64.

POSITIVE AIR RETURN SYSTEM, including street steam systems, atmospheric systems, back pressure systems and vapor systems, sold by the Positive Differential System Company,

New York, are discussed in a new catalogue issued by this company. Attention is called at the beginning of the catalogue to the recent developments in the design of steam heating systems which have divided them into two distinct classes, air valve systems and air return systems. Air valve systems are described as those which require an air valve upon each radiator, while air return systems are those in which the air is carried down the return pipe, together with the return water, and discharged in the basement or boiler room. Where the steam is circulated at a pressure only slightly above that of the atmosphere, the air is usually forced out through a vent pipe or an air valve. Where the steam is at atmospheric pressure, or slightly below, the air is usually withdrawn by a vacuum pump. The two systems are further distinguished by the fact that in an air valve system it is always necessary to have the controlling valves of the radiators either entirely open, thus heating the unit completely, or else have them tightly closed. Any intermediate position of the valves results in the accumulation of water in the radiators. This causes water hammer, and perhaps the lowering of the water in the boiler to a dangerous point. In the air return system, on the other hand, the fractional valve upon the inlet of the radiator may be so adjusted that any desired amount of steam may be admitted, thus partially heating the radiator in proper relation to the outside weather, so that any preferred temperature of the room may be maintained. The catalogue then takes up the devices used with the Positive air return system, including the fractional valve, the impulse valve to control the flow of water and steam from the radiator, and the thermo-float air valve which closes against the passage of either water or steam. It is stated that a plant equipped with these devices will retain all the advantages of the ordinary one or two-pipe gravity system, in that it can be operated at any pressure, while it eliminates all air valves from radiators and does away with the necessity of having radiator valves either fully open or tightly closed. A number of buildings are shown which are equipped with Positive air return systems and, in addition, a list is given of some of the company's large and smaller installations. Size 6 x 9 in. (standard). Pp. 16.

Betson's Plastic Fire Brick, for making right in place jointless one-piece boiler furnace linings, including door arches and whole firebox fronts, entire side walls, bridge and back arch and baffles, together with instructions for using same, are the subject of a 20-page booklet published by the Betson Plastic Fire Brick Company, Rome, N. Y. The booklet also gives directions for the testing of boiler settings for air leaks and for the immediate repair, without shutdown, of cracks and holes to preserve the life of ordinary brick linings to the time when they can be replaced. Illustrations and diagrams show the one-piece lining as applied to the several types of boilers in general use. Size 4 x 9 in.

Marsh Valves, including union bonnet double seat and special radiator double seat valves, made by the Marsh Valve Company, Erie, Pa., are the subject of new circulars just issued by this company. Special attention is called to four features: (1) That all Marsh valves contain an upper seal, formed by a composition disc and a finished metal seat in the bonnet, providing a positive seal against leakage around the stem when the valve is fully open; (2) that the company is prepared to furnish all the valves used in a heating system, including mill supply globe, angle and gate valves for piping jobs, and any style of union bonnet or special screwed bonnet radiator pattern, required for radiators; (3) that the discs of Marsh valves, both upper and lower, are manufactured by the B. F. Goodrich Company, Akron, O., and are guaranteed as to quality. The lower discs are of the oblong hole type, standard size, and interchange with all the high-grade makes. (4) That the Marsh union bonnet valves do not cost more than other high-grade valves and that the company's special radiator valves cost less, and but little more than low-priced competition lines. The company guarantees all of its valves. In specifying radiator valves, it is pointed out that a distinction should be made as to whether the union bonnet or the screwed bonnet pattern is desired. Size of circulars 3¼ x 6½ in. Pp. 16, 16 and 6, respectively.

Psychrometric Tables for Cooling Tower Work, being a companion book to "Steam Tables for Condenser Work," will shortly be published by the Wheeler Condenser & Engineering Co., Cartaret, N. J. Judging from the advance proofs, the booklet will be fully up to the standard of the advanced type of engineering trade publications which aim to be of real value to the engineer as well as to the manufacturer. This booklet really constitutes a handbook of tables giving dry and wet bulb thermometer readings, dew point, humidity and the pounds of water vapor per 1,000 cu. ft. and per 100 lbs. of air, together with a well-written discussion of psychrometry and the use of the sling psychrometer. The company's imprint states that it was the pioneer American condenser builder. Size 4 x 6¾ in. Pp. 50.

Powell Appliances, 1915, for automobiles, trucks, motorboats, gas, gasoline and oil engines, is the latest of a series of catalogues published by the Wm. Powell Company, Cin-

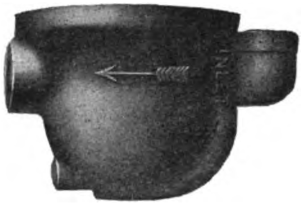
cinnati, O., well known as manufacturers of steam fittings and accessories of all kinds. For many years past the company has made a point of issuing at frequent intervals a series of booklets which not only illustrate the company's goods and list prices, but also give details and particulars not generally found in catalogues, thus obviating the necessity of writing the manufacturers for information. The company's line of "White Star" valves is prominently featured, and it is stated that the company is prepared at all times to furnish non-corrosive valves, cocks and fittings at special prices. Patrons are reminded that all articles bearing the Powell trade-mark are sold and guaranteed as to their mechanical perfection and superior workmanship. Size 5¼ x 7¾ in. Pp. 56.

VALVE WORLD for October, 1915, the monthly periodical of the Crane Company, Chicago, has an important article on "Pipe Bends—Their Growing Use and Efficacy," containing data and charts compiled by the mechanical expert's department of the Crane Company. This company has recently finished exhaustive tests with various types of bends in several sizes and weights of pipe to determine their relative value with regard to expansion and contraction. The results of these tests are given, while the charts include curves showing the expansion for bends placed in line without springing.

CONNERSVILLE VALVELESS ROTARY VACUUM PUMPS, for heating systems, vacuum cleaning, etc., are concisely treated in a circular published by the Connersville Blower Company, Connersville, Ind. The features of this pump which are especially mentioned are: no valves or valve ports, only two moving elements, no light or delicate parts, no internal contact or wear, no reciprocating motion, no reversals to limit speed and capacity, balanced at all speeds, minimum vibration, will handle air, gas, steam, water and all fluids; has six large bearings, ring-oiling type; furnished in all sizes and capacities, for all vacuums; and, finally, are a proven success.

MARSH SPECIAL OUNCE GRADUATION LOW PRESSURE RETARD GAUGES, for use on any low pressure boiler, is a recent product of Jas. P. Marsh & Co., Chicago, which is featured in new circular matter. This line includes pressure, compound pressure and vacuum gauges. The pressure gauge is for use on any low pressure boiler where the average pressure is to be recorded in ounces to 10 lbs. or less. The compound gauge is for use on the boiler of any low pressure, vapor or vacuum steam heating system where the average pressure to be recorded in ounces is 5 lbs. or less; also where the vacuum is to be recorded in ½-in. graduations to the depth of 10 in. These gauges, it is stated, may also be installed at desired points in the feed or return piping to indicate exact pressure in ounces or amounts of vacuum in ½-in. registrations at any location in the heating system. The gauge is furnished for all makes, styles and sizes of low pressure steam boilers. The list price, including cock, is $8.00 each. The same circular also features the Marsh special shank combined altitude gauge and thermometer for hot water boilers of closed or open systems, combining in one instrument an accurate altitude gauge and a reliable, protected thermometer. It is graduated to register any altitude of water up to 70 ft., while the thermometer and scale indicates any temperature from 40° to 240° F. The list price is $5.00 each.

JOHNS-MANVILLE STEAM TRAP, a recent product of the H. W. Johns-Manville Company, New York, is described in a newly-issued catalogue as the simplest trap made, comprising but three parts—the cover, body and rolling ball. The ball is the only movable part of



JOHNS-MANVILLE STEAM TRAP.

the complete device. The principle of operation is that the non-attached rolling ball is subject to a pressure equal at all points except that area resting against the discharge orifice. When condensation enters the trap through the inlet, the ball rolls up, exposing the discharge opening, which permits a discharge of water and air without any loss of steam. It is pointed out that this discharge is constant and automatic; also that the trap cannot air-bind, because the air, being heavier than steam and lighter than water, forms a film on the surface of the water and is carried out with it. While the condensation acts as a lifting force which is responsible for the outlet being uncovered, allowing the escape of water, air and other gases, the steam pressure simultaneously forces the ball to seat itself against the upper part of the opening with sufficient pressure to prevent any discharge of steam. Another feature mentioned is that the ball re-adapts itself to its seat automatically every time the trap discharges and is always kept clean. The Johns-Manville trap is made in five sizes, ranging in capacity from 750 sq. ft. of radiation to 10,000 sq. ft., and emphasis is laid on the statement that the trap capacities given are average and not the maximum capacity for the pipe size shown. Size 6 x 9 in. (standard). Pp. 8.

Panama-Pacific International Exposition.

7—AMERICAN RADIATOR COMPANY.

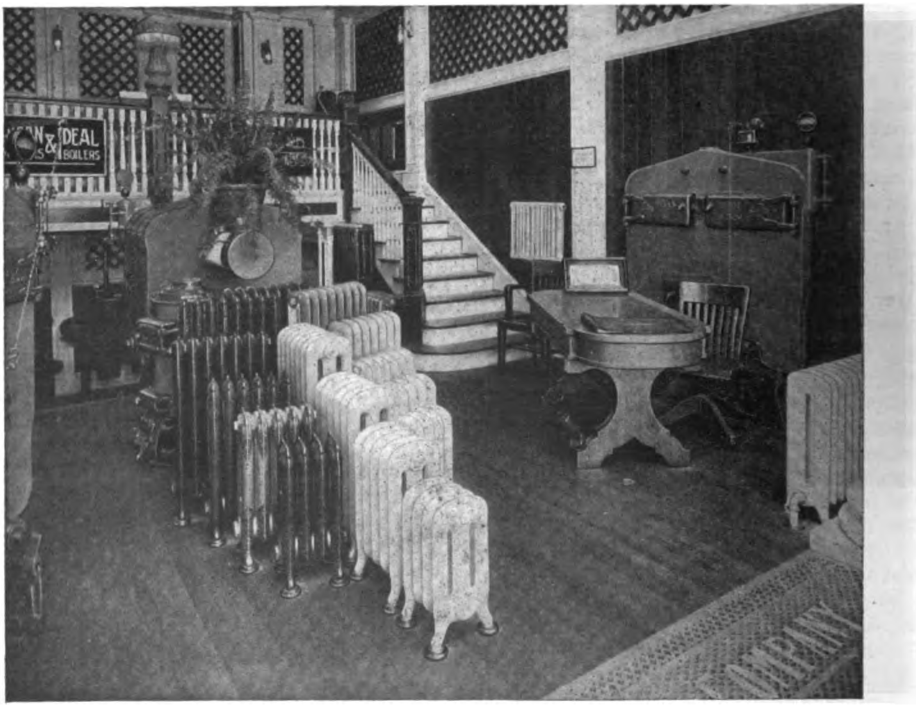
Three floor levels are employed by the American Radiator Company, Chicago, Ill., in their exhibit at the Panama-Pacific International Exposition, to demonstrate to the public the method of properly heating a home with American radiators and Ideal boilers; also for cleaning with Arco Wand vacuum cleaners. The entire arrangement of the exhibit, including decoration, furnishings, etc., is designed to give a homelike appearance to the display. The room is finished in white tile and the boilers are covered with white asbestos and have polished brass trimmings.

The company's display has won for it the award of the Grand Prize, which was also the award of this company at the previous world's expositions in Chicago, Paris, St. Louis and Brussels.

ENTRANCE TO EXHIBIT OF THE AMERICAN RADIATOR CO.

8—NATIONAL TUBE COMPANY.

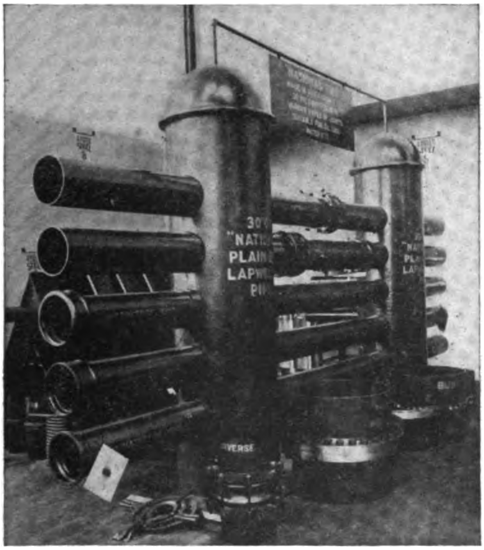
A total floor area of 6,000 sq. ft. is occupied by the exhibit of the National Tube Company which is a part of the display of the United States Steel Corporation at the Panama-Pacific International Exposition. The exhibit is located in the Palace of Mines and Metallurgy. The products of the National Tube Company are National pipe and allied tubular products, Kewanee specialties, fittings, etc., and Shelby seamless tubing and cylinders.



MAIN DISPLAY OF THE AMERICAN RADIATOR COMPANY AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION, IN SAN FRANCISCO.

Entering the main section, the visitor walks through a large arch, 15 ft. in height, made of miscellaneous bends of 4-in. National pipe. Immediately behind this is a massive rack, on which are displayed the various types of National pipe used in the oil fields. Capping this rack is the largest and longest individual length of lap-welded wrought pipe ever made in America, consisting of one length of 20-in. O. D. National pipe, 39 ft. 6 in. long. This "double" length of National pipe was welded at the National works of the National Tube Company at McKeesport, Pa.

Probably the most commanding feature of the main booth is the colossal model, made to exact proportions, of a 2-in. octagon Kewanee union. Another exhibit shows freak specimens of casings which have encountered unusual and severe service. Further on are two large mahogany frames, with concealed electric lights, which enclose samples of corroded pipe, representing both wrought iron and steel. These samples show comparisons of the two kinds of pipe taken from the same line, used for the same service, and for the same length of time. The lines they were

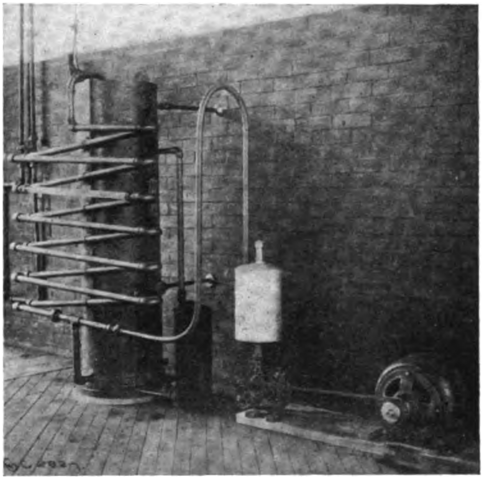


PART OF NATIONAL TUBE COMPANY'S EXHIBIT AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION, SHOWING "NATIONAL" PIPE EQUIPPED WITH VARIOUS TYPES OF JOINTS; ALSO 30-IN. "NATIONAL" PIPE STANDARD.

taken from include feed water, heating and hot water lines.

In this connection a special apparatus is shown of an open heating system for making corrosion tests. This consists of a hot water tank, a water heater with thermostat, an air pump and several coils of pipe made of alternate lengths of wrought iron, ordinary steel and National pipe. Air is injected into the hot water which is forced up through these coils into the tank. The corrosion is quite rapid, as the service is severe, it being estimated that one month of this test is equivalent to one year in the average hot water line.

The tank is made of a piece of Matheson joint pipe in which a bottom has been



OPEN HEATING SYSTEM FOR CORROSION TESTS IN THE EXHIBIT OF THE NATIONAL TUBE COMPANY AT SAN FRANCISCO.

welded; the Lawson heater is used for keeping the water hot in the tank. There is also a blower or other source of air supply, and a test coil made up of alternate pieces of various pipes under test, with auxiliary fittings and a glass observation tube. The water is kept at a constant temperature by means of a thermostat controlling the gas supply. A thermostat is attached to the side to observe the temperature. The water is kept at a constant level by means of a ball cock attached to the outlet from a service line.

Tests are made by circulating the hot water from the tank through the coil by means of the air which is brought in at the bottom of the coil through an injector, which acts as an air lift for the water. By proper control of the air supply the water may be made to flow from the bottom of the tank through the coil and spill over the top into the tank at such a rate that there is just a gentle surging in

the pipes and the products of the corrosion are not stirred up with resultant coloration of the water. Under these conditions, circulation of the water will be at the rate of about 1⅛ gal. per minute.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

AIR CLEANING—

Test for Dirt in an Air Supply. Sanford A. Mors. A new method of test. Ills. 1,800 w. Gen. Elec. Rev.—July, 1915. 40c.

HOT-WATER HEATING—

District Heating with Open Heater. Thomas Wilson. Privately owned electric plant at Laporte, Ind., using exhaust for hot-water heating. Ills. 2,000 w. Power—July 13, 1915. 20c.

PIPING—

Underground Pipe Mains for Steam and Hot-Water Heating. Charles L. Hubbard. How to design and install them. Ills. 2,000 w. Natl. Engr.—July, 1915. 20c.

SCHOOLHOUSES—

The Heating and Ventilation of Schoolhouses. Harold L. Alt. Methods giving greatest satisfaction. Ills. 2,500 w. Br. Build.—July, 1915. 60c.

ADVERTISERS' INDEX

THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK NOVEMBER, 1915

Hot Water Heating on a Large Scale

CENTRAL HEATING PLANT FOR THE STATE SCHOOL OF AGRICULTURE, FARMINGDALE, LONG ISLAND.

For the past three years the Departmen of Agriculture of the State of New York, under the direction of Lewis F. Pilcher, State architect, and G. B. Nichols, chief engineer, has been giving considerable study to the problem of heating institutions from a central plant. With the large number of institutions under its direct observation, it has come to the conclusion that an institution can be so designed that, in the arrangement of its buildings to the power-house location, forced hot water heating is preferable. This is particularly so where the institution is built on a large flat plateau, or where the buildings are divided into groups, each group being on a flat plateau, with the groups as few in number as possible.

There is also considerable advantage in having the buildings arranged in loops, each loop being fed by a one-pipe underground system, the power house being located on the loop. There has also been forcibly brought to the attention of this department both the lack of definite information in connection with this form of heating and also the difference of opinion on the subject that exists among recognized engineers.

After a great deal of study had been given to the establishment of one of the larger institutions, it was decided that at the Long Island Agricultural School, Farmingdale, Long Island, a central forced hot water heating system could be designed that would fulfil all of the requirements of this system for economical operation.

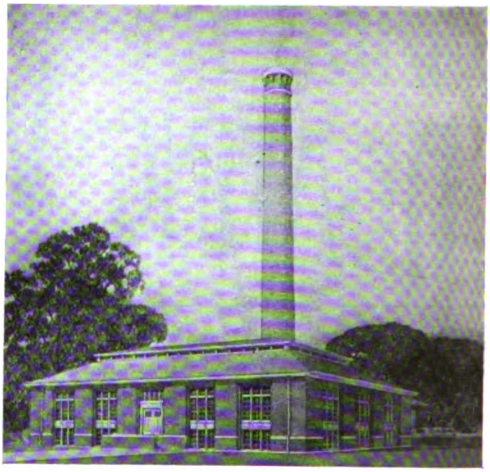
The school is planned for both sexes and will accommodate, when complete,

GENERAL VIEW OF STATE SCHOOL OF AGRICULTURE, FARMINGDALE, L. I.

1,000 pupils, which forms the basis of the design.

The arrangement of buildings centers about two perpendicular axes, as shown on the accompanying block plan. Approximately at the extremity of one of these axes is located the power house. To the west of the center is located the boys' group, consisting of two-story dormitories, and on the same axis, to the extreme east, is located the girls' group, which will consist of two-story cottages, in which the girls can live in small groups. Near the center of the institution are located the school and administration buildings, together with buildings for the study of agricultural purposes. All of these buildings are located on a large flat plateau, approximately 2,000 ft. in length by 1,500 ft. in length on the other axis.

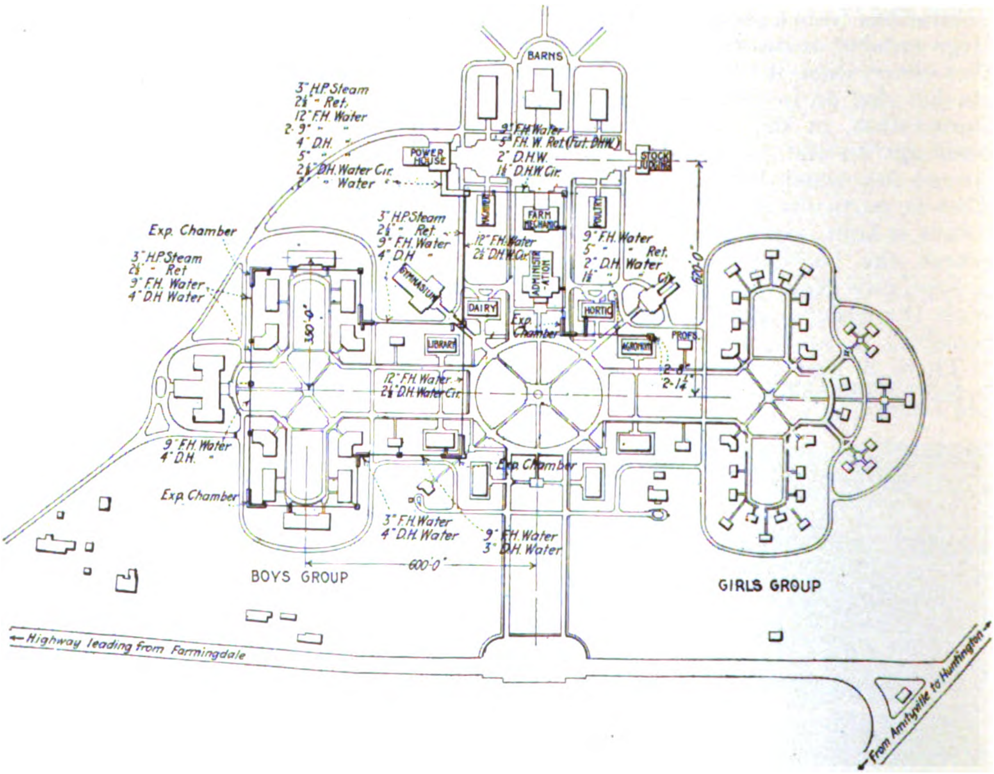
The design calls for approximately 100,000 sq. ft. of equivalent direct radiation for this institution, one-half of which is located in the boys' group and one-half in the girls' group.



POWER HOUSE, STATE AGRICULTURAL COLLEGE.

PRESENT INSTALLATION FOR BOYS' GROUP.

The larger number of buildings to be erected at the present time are located in the boys' group and there has already been installed a central hot water heat-



BLOCK PLAN OF NEW YORK STATE SCHOOL OF AGRICULTURE, FARMINGDALE, L. I.

ing, one-pipe, underground loop, starting from the power house and running alongside of site of each building in the boys' group, thence returning to the power house. This loop consists of a 9-in. forced hot water heating main, together with a 4-in. domestic hot water main, both run underground in sectional tile conduit of the Johns-Manville Company's manufacture.

That portion of the main from the power house to the center of the boys' group consists of a 12-in. forced hot water main, which portion has been increased in size to provide for a future similar loop running through the girls' group. At the present time, only a portion of this second loop has been installed and the future domestic hot water return is temporarily being used as the return for the forced hot water heating system and temporary domestic hot water pipes have been installed for the buildings now being erected on the east loop.

The buildings are connected to the mains by walking tunnels approximately 20 ft. in length so as to provide for expansion of pipes. At the changes in direction in the underground mains, anchors or expansion chambers have been provided, the length of the expansion chambers being determined by the amount of expansion in the pipe between chamber and anchor.

TWO-PIPE GRAVITY SYSTEM USED.

All of the buildings are piped on the two-pipe gravity system, and the flow and return mains are connected to the underground main within a few feet of each other. The floor main rises at the entrance to building to the basement ceiling, while the return is run near the floor line.

The power house consists of a two-story, brick building, the upper portion of which, for the present, will be used for school purposes; when the institution has been completely developed, this will be used for a laundry. This location is of considerable advantage, as in institutional work, it has been found that a greater portion of the domestic hot water, steam and electric service is consumed for laundry purposes; therefore, the site of this activity should be as near as possible to the power house supplying these services.

High pressure steam is also to be carried to the kitchen building at the center of the boys' group, although it is believed that in the near future, on account of the high maintenance cost of this main, which is in continual use throughout the year, that electric cooking may be substituted in the finally-developed plan for this institution, thereby eliminating loss on these high pressure steam mains for continual use for minimum service only.

ARRANGEMENT OF POWER HOUSE.

It will be noticed from the first-story floor plan of the power house that the building is divided into three portions; one part arranged to accommodate the engine, pumping equipment and water heaters; a second part consisting of the boiler room; and the third, coal pockets; with smaller rooms for engineer's office, supplies, locker, engineer's toilet, and employees' toilet.

The building is so designed that the boiler room and coal pocket can be indefinitely extended, making it possible to only build a portion of the building at the present time; also that the coal pocket can grow in proportion to the size of the boiler room.

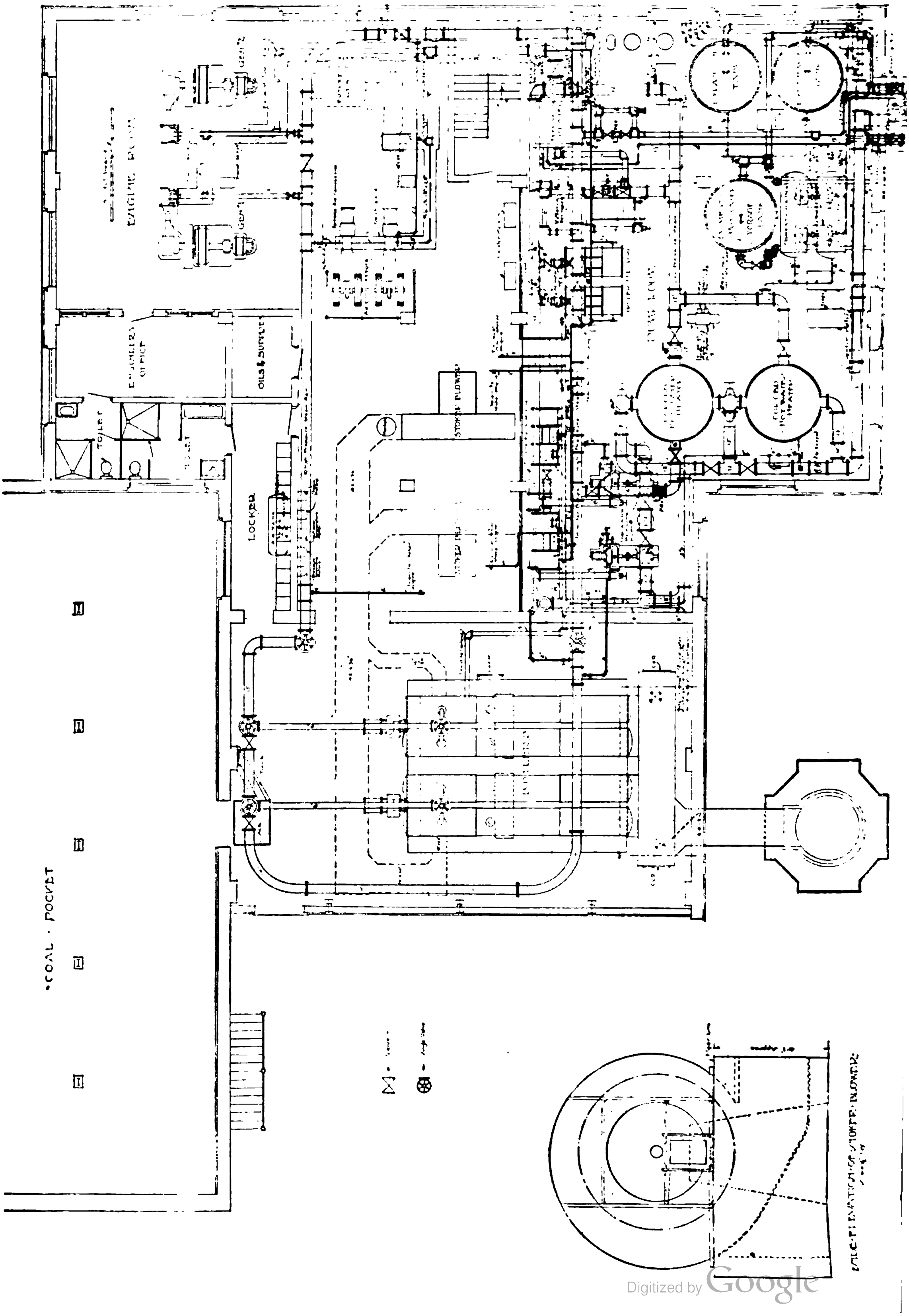
It has been found by experience that the demand for increase in electric power has been very small in this class of service, as with the increase in lamp efficiencies, the increase in demand for this class of service has been less than the decrease due to increase in lamp efficiencies.

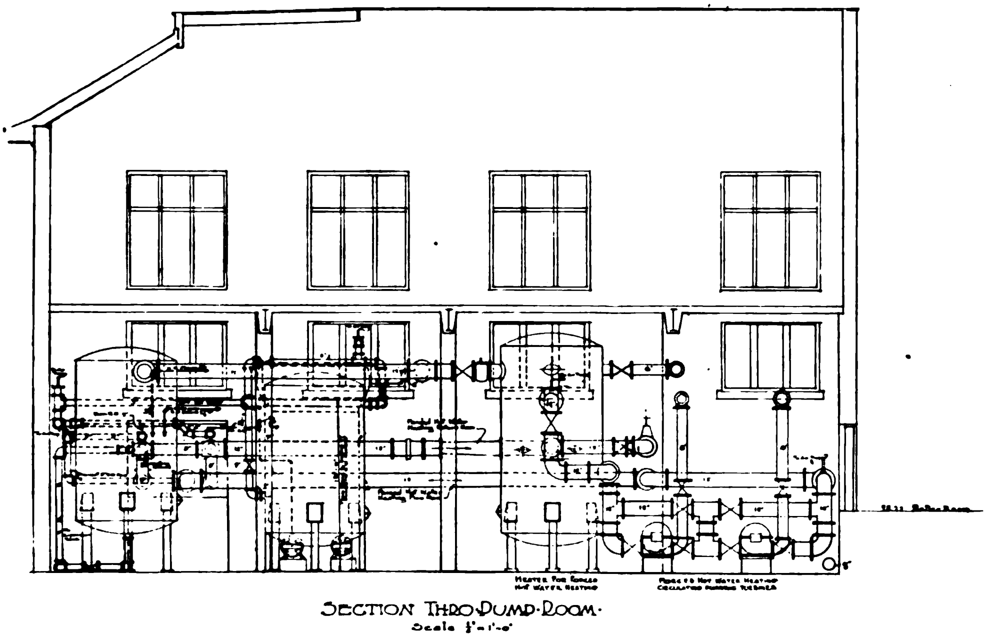
The stack is a radial brick stack, 150 ft. high by 6 ft. 6 in. in diameter.

At the present time, there has been installed two 200 H. P. Keeler non-sectional water-tube boilers, with red pressed brick outer walls, Jones underfeed stokers, and two direct-connected blowers, each designed for a maximum of 1,200 boiler H. P.

In the engine room there has been installed two 50 K. W., 3-phase, 60 cycle, 2,300 volt, alternating current, Fort Wayne generators, with direct-connected exciters and direct-connected Harrisburg Foundry & Machine Company's engines.

The switchboard is of marble and con-


OILS & SUPPLY
TOILET
TOILET
LOCKER
STOKER BLOWER
STOKER BLOWER
COAL · POCKET



SECTION THROUGH PUMP ROOM.

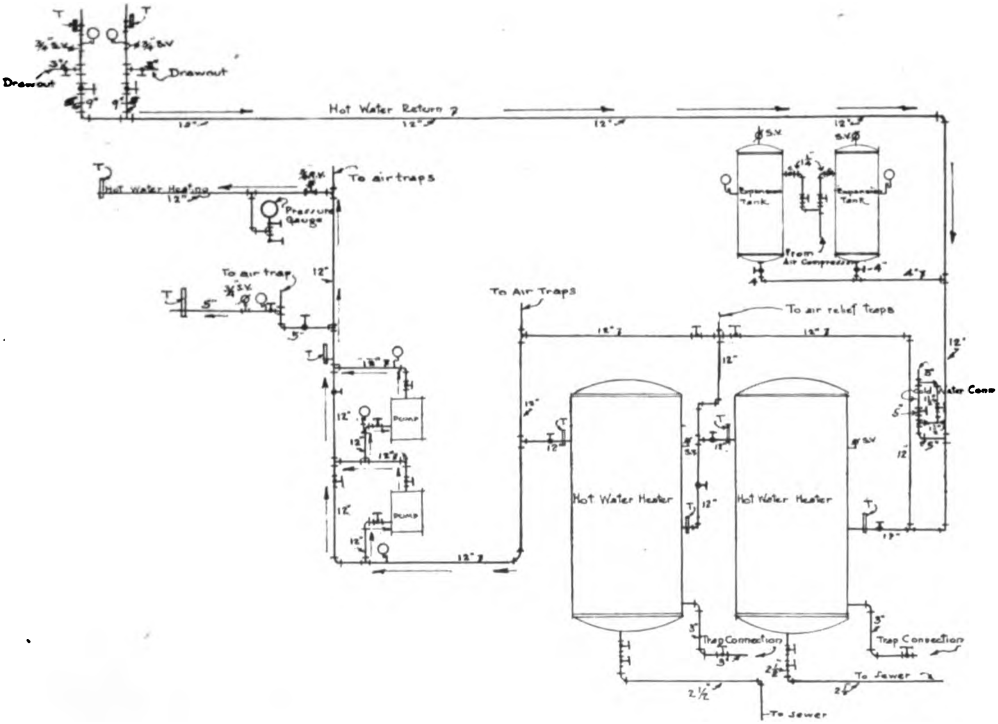


DIAGRAM OF CONNECTIONS FOR FORCED HOT WATER HEATING SYSTEM.

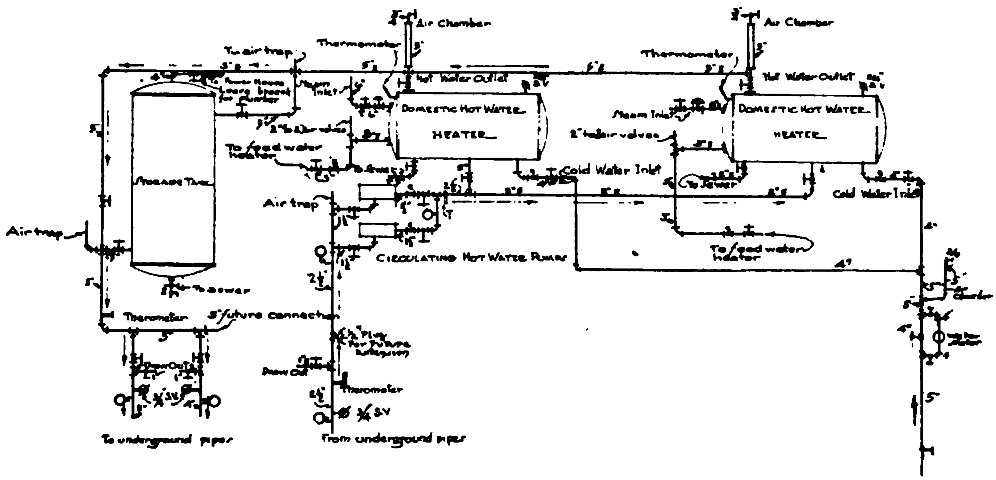


DIAGRAM OF DOMESTIC HOT WATER HEATER CONNECTIONS.

sists of generator and feeder panels, also furnished by the Fort Wayne Electric Company.

The water supply of the institution is taken from artesian wells located in the vicinity of the power house. These wells are to be pumped by air lift to a concrete receiving basin, located at the surface of the ground. The air compressors are located near the generators and are of the Laidlow-Dunn-Gordon manufacture. From the receiving basin the water is to be pumped by two force pumps to a steel tower tank located at the highest point of the institution directly behind the power house.

The forced hot water heaters consist of two Sims steam-tube heaters, especially designed for this class of service, as shown on the accompanying detail, and consist of an 8 ft. in diameter tank, in which are located 664 2-in. tubes, each tube being 6 ft. long, thereby giving 2,100 sq. ft. of heating surface for

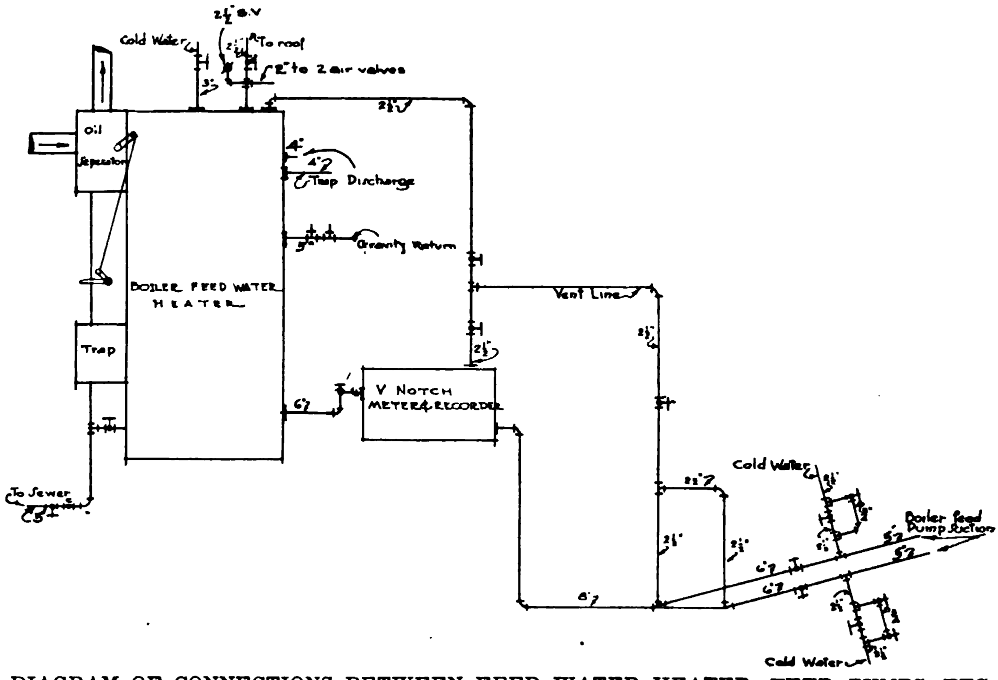
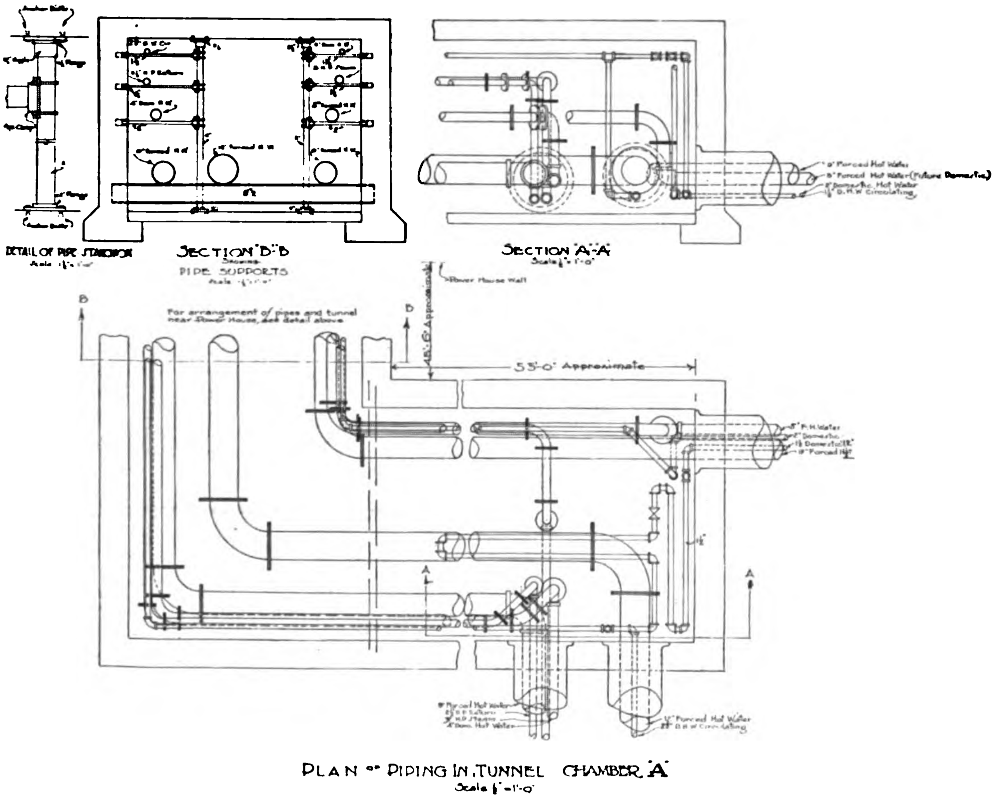
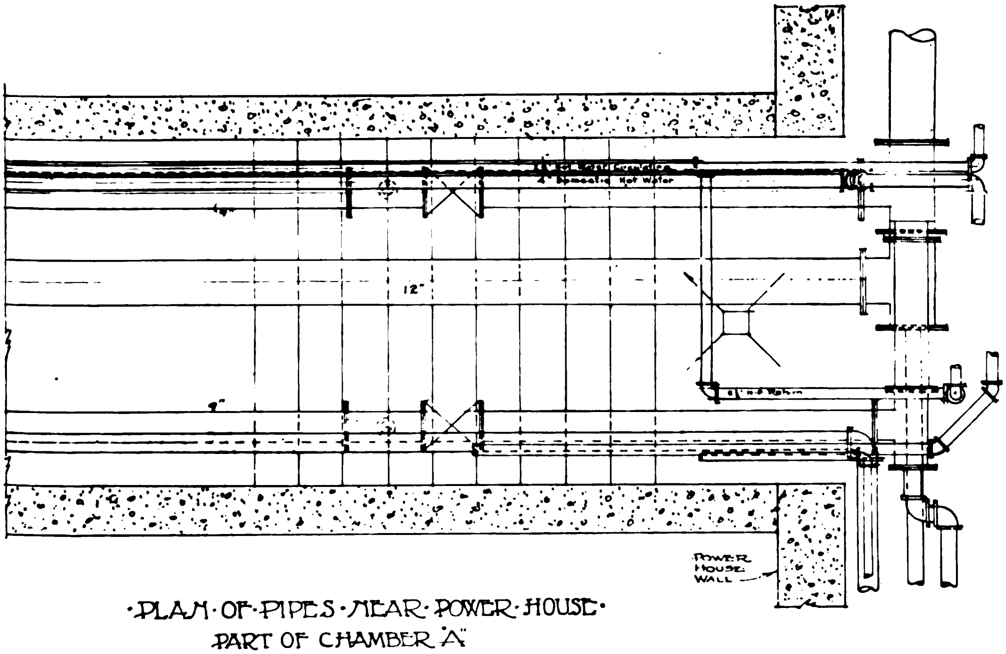


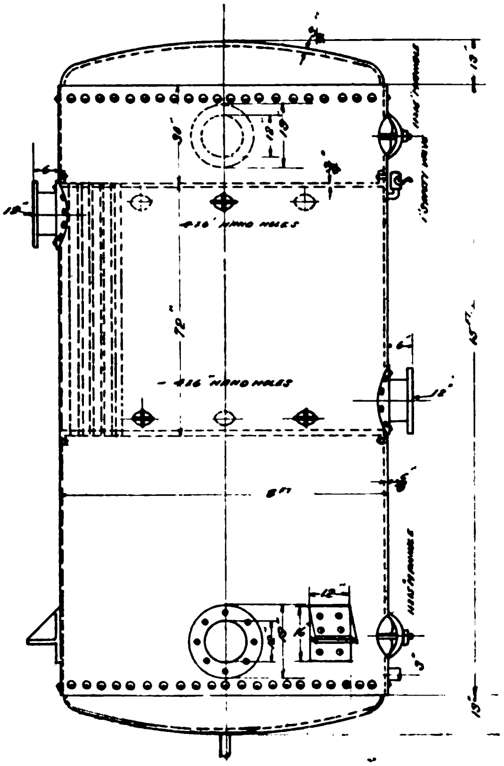
DIAGRAM OF CONNECTIONS BETWEEN FEED WATER HEATER, FEED PUMPS, ETC.



PLAN OF PIPING IN TUNNEL, CHAMBER A



PLAN OF PIPES NEAR POWER HOUSE, PART OF CHAMBER A.



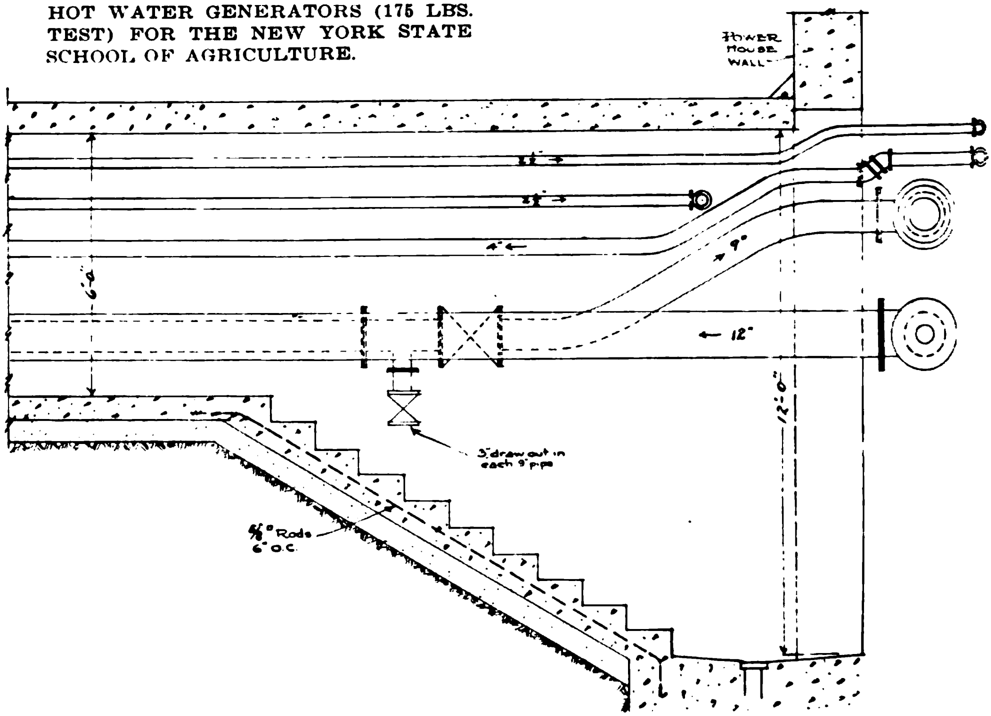
DETAIL DRAWING OF SIMS FORCED HOT WATER GENERATORS (175 LBS. TEST) FOR THE NEW YORK STATE SCHOOL OF AGRICULTURE.

each heater. These heaters are so connected that either heater can be supplied with exhaust steam and, in addition, one heater can be used as a primary heater, being supplied with high pressure steam, while the other is being used as a secondary heater, and supplied with low pressure exhaust steam. Presumably during mild weather, both heaters will be supplied with low pressure steam.

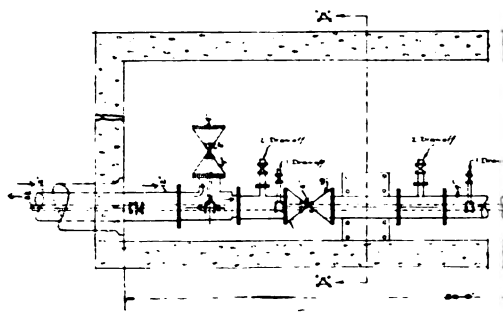
There are also connected to the forced hot water main two expansion tanks, each consisting of a steel tank 7 ft. 6 in. in diameter by 13 ft. high.

The heaters and expansion tanks are designed for a shop test of 175 lbs. pressure and a working pressure of 80 lbs. per square inch.

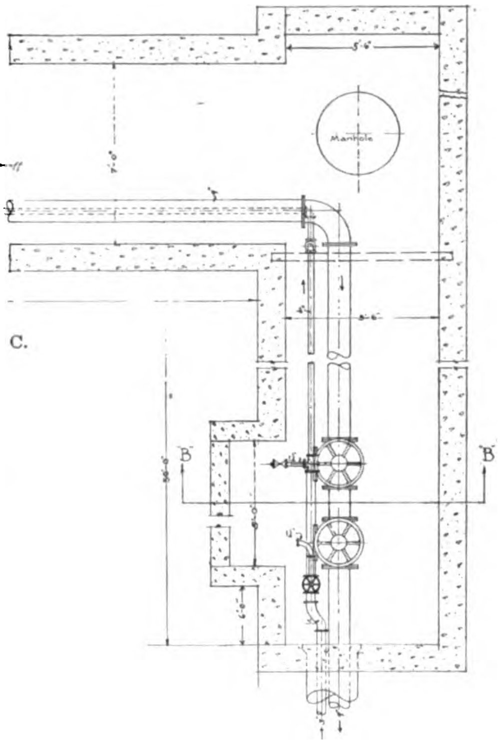
Circulation is to be maintained in the hot water heating mains by two direct-connected centrifugal pumps, each pump capable of discharging 2,500 gals. of water per minute against a head of 20 lbs. per square inch. Each pump is direct-connected to a steam turbine. The pumps are so connected that they can be operated in series or independently and are



ELEVATION OF PIPES AT POWER HOUSE, CHAMBER A.



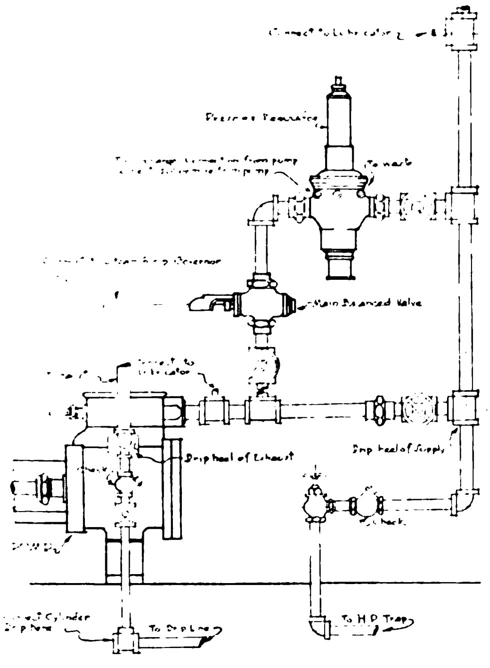
EXPANSION CHAMBER C.



capable of pumping the maximum demand in water service, the pressure being increased when the pumps are in series.

All of the returns from the heaters are trapped to a feed water heater of the Webster type, from which the returns flow by gravity to a V-notch recorder of the Yarnall-Waring manufacture. From thence the feed water is pumped through duplicate boiler feed pumps of the Worthington manufacture, thence to the boilers.

The domestic hot water is heated by two Sims steam-tube heaters, each being of 4,000 gals. capacity per hour. This type was selected on account of its large water capacity. So as to properly circulate the domestic hot water, there were installed two duplicate centrifugal pumps, direct-connected to motors, each being of 40 gals. per minute capacity, against a head of 10 pounds per square inch.



DETAIL OF SPEED PRESSURE REGULATOR.

METER INSTALLATION.

So as to keep track of the costs of operation of this plant and to properly distribute same, the following meters were installed:

One Venturi meter, manufactured by the Builders' Iron Foundry, to measure the amount of water pumped through the forced hot water heating system.

Two tempearture recording meters, one on the flow and the other on the return of the forced hot water heating mains.

One cold water meter measuring water supply to the domestic hot water heaters.

One cold water meter on make-up feed water connected indirectly at the boiler feed pumps.

One cold water meter for make-up cold water supplied to the feed water heater.

One outdoor temperature recording meter.

One steam recording meter of General

Electric Company's make, connected to the high pressure steam main supplying steam to the engine room main.

A similar meter is located on the high pressure steam header connected to the pump room apparatus.

There are also installed indicating steam flow meters on each boiler, together with steam recording pressure gauges connected to the high and low pressure mains.

Indicating thermometers were located at various points in the forced hot water heating main and boiler feed supply. Platform scales for weighing the coal delivered to the boiler room have also been installed.

Although the operating cost of such a plant will be somewhat higher for a number of years, due to a large number of pieces of apparatus being under partial load until the institution is finally developed, it is reasonable to expect that this plant in operation can be run economically and also that reliable information will be obtained, which will form the basis for the design of future plants.

All of the work is being installed by Albert Winternitz, heating contractor, New York City, and will be in actual operation by November 15. The contract for the power house equipment, together with that portion of underground heating mains at the present time being installed is $103,300.

Undoubtedly this is one of the first institutions of its kind in which the ultimate number of buildings have been planned for, so that the buildings and equipment now being installed will form a part of the final scheme and will not have to be replaced or removed at some future date.

It is noticeable also that the heating contract for the present institution is approximately 25 per cent. of the total present cost, it being considered advisable to install the mechanical portion of the institution at the present time, particularly, as much as possible of the underground mains, so that the grounds would not have to be disturbed at a future time.

New Pipe Chart and Tables Based on Square Feet of Radiation

For Use in Determining Sizes of Steam Supply Mains and Branches for Low Pressure Steam Heating Systems.

By T. W. Reynolds.

Tables giving the capacity of steam supply mains and their branches are usually computed for the weight of steam in pounds per minute, with the initial pressure far in excess of that required for ordinary low pressure steam heating mains. The size of pipe required for varying amounts of radiation and other variables is seldom given directly in most formulae. As this is usually the result desired, it follows that the solution must be worked out backwards by a hit or miss method from formulas giving the amount of radiation or weight of steam supplied for any pipe size or other variable.

Also to compute or modify such tables in conformance with the required conditions under which a heating system is to be operated, the calculations must of necessity involve considerable time and patience. The few tables published on this subject, rate the capacity of steam supply mains in square feet of radiation, but fail to give such essential details as the initial pressure, drop in pressure between the source and terminal of the main, or the basic formula upon which the tables were computed, thereby leaving the user in more or less of a quandary as to the reliability of the table in question. Furthermore, it would be almost impossible to calculate a set of tables to suit any possible case that might arise.

In order to overcome the above difficulties the following tables and chart were computed, which may be of service to others having like difficulties.

THE FORMULA USED.

The formula used was one given by Professor R. C. Carpenter in the Trans.

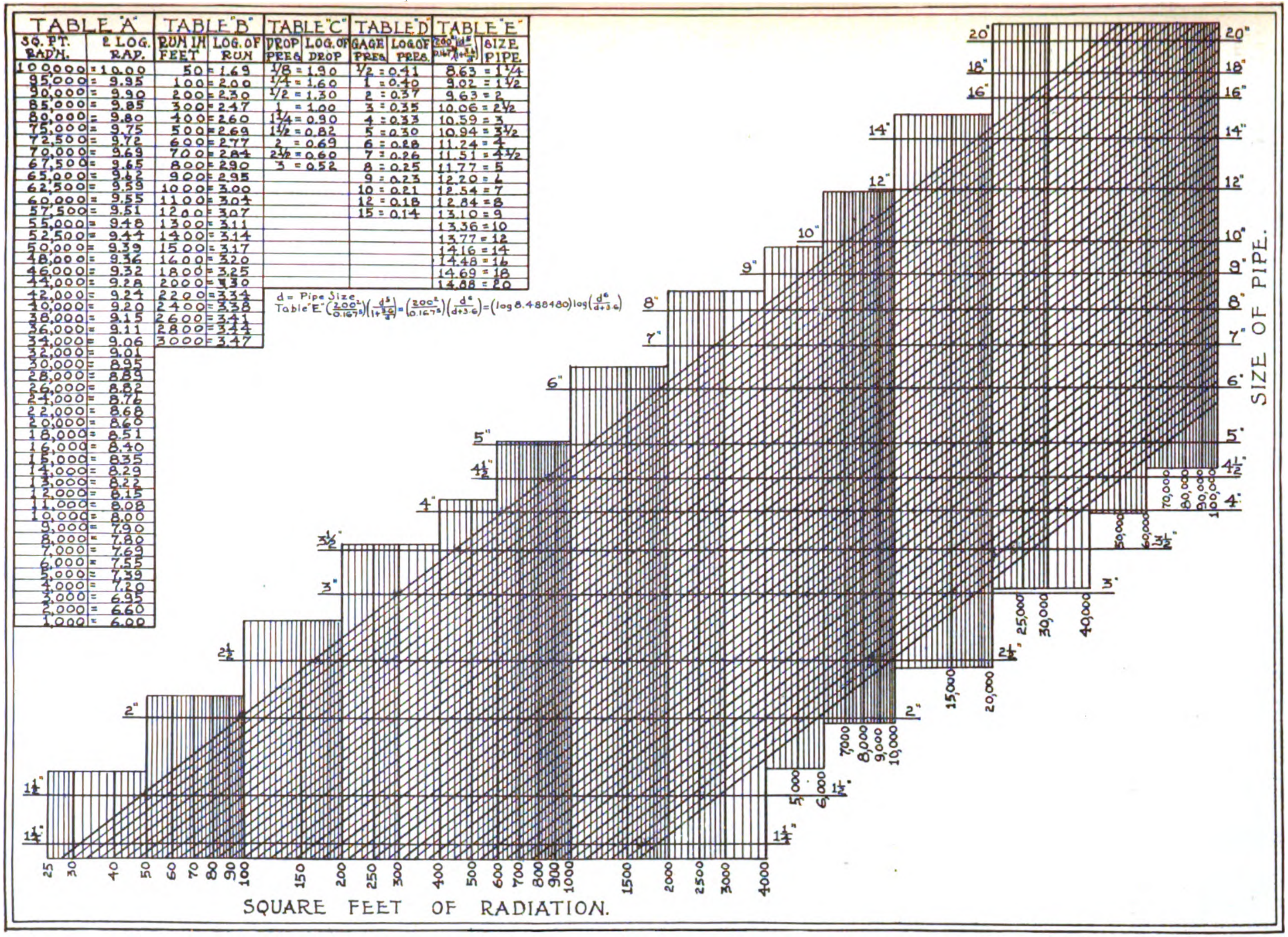


TABLE "A"

SQ. FT. RAD'N.	2 LOG. RAP.
100,000	= 10.00
95,000	= 9.95
90,000	= 9.90
85,000	= 9.85
80,000	= 9.80
75,000	= 9.75
72,500	= 9.72
70,000	= 9.69
67,500	= 9.65
65,000	= 9.62
62,500	= 9.59
60,000	= 9.55
57,500	= 9.51
55,000	= 9.48
52,500	= 9.44
50,000	= 9.39
48,000	= 9.36
46,000	= 9.32
44,000	= 9.28
42,000	= 9.24
40,000	= 9.20
38,000	= 9.15
36,000	= 9.11
34,000	= 9.06
32,000	= 9.01
30,000	= 8.95
28,000	= 8.89
26,000	= 8.82
24,000	= 8.76
22,000	= 8.68
20,000	= 8.60
18,000	= 8.51
16,000	= 8.40
15,000	= 8.35
14,000	= 8.29
13,000	= 8.22
12,000	= 8.15
11,000	= 8.08
10,000	= 8.00
9,000	= 7.90
8,000	= 7.80
7,000	= 7.69
6,000	= 7.55
5,000	= 7.39
4,000	= 7.20
3,000	= 6.95
2,000	= 6.60
1,000	= 6.00

TABLE "B"

RUN IN FEET	LOG. OF RUN
50	= 1.69
100	= 2.00
200	= 2.30
300	= 2.47
400	= 2.60
500	= 2.69
600	= 2.77
700	= 2.84
800	= 2.90
900	= 2.95
1000	= 3.00
1100	= 3.04
1200	= 3.07
1300	= 3.11
1400	= 3.14
1500	= 3.17
1600	= 3.20
1800	= 3.25
2000	= 3.30
2200	= 3.34
2400	= 3.38
2600	= 3.41
2800	= 3.44
3000	= 3.47

TABLE "C"

DROP PRES.	LOG. OF DROP
1/8	= 1.90
1/4	= 1.60
1/2	= 1.30
1	= 1.00
1¼	= 0.90
1½	= 0.82
2	= 0.69
2½	= 0.60
3	= 0.52

TABLE "D"

GAGE PRES.	LOG. OF PRES.
½	= 0.41
1	= 0.40
2	= 0.37
3	= 0.35
4	= 0.33
5	= 0.30
6	= 0.28
7	= 0.26
8	= 0.25
9	= 0.23
10	= 0.21
12	= 0.18
15	= 0.14

TABLE "E"

$\frac{200^2}{0.167^5}\left(\frac{d^5}{1+\frac{3.6}{d}}\right)$	SIZE PIPE.
8.63	= 1¼
9.02	= 1½
9.63	= 2
10.06	= 2½
10.59	= 3
10.94	= 3½
11.24	= 4
11.51	= 4½
11.77	= 5
12.20	= 6
12.54	= 7
12.84	= 8
13.10	= 9
13.36	= 10
13.77	= 12
14.16	= 14
14.48	= 16
14.69	= 18
14.88	= 20

d = Pipe Size

Table "E" $\left(\frac{200^2}{0.167^5}\right)\left(\frac{d^5}{1+\frac{3.6}{d}}\right)=\left(\frac{200^2}{0.167^5}\right)\left(\frac{d^6}{d+3.6}\right)=\left(\log 8.488480\right)\log\left(\frac{d^6}{d+3.6}\right)$

NEW RADIATION CHART AND TABLES.

A. S. M. E. Vol. XX, which is similar to an equation given by Babcock in "Steam" and repeatedly referred to by various authors.

$$(1) \qquad d = 0.167 \sqrt[5]{\frac{W^2\left(1 + \frac{3.6}{d}\right)L}{P^D}}$$

In which d = internal diameter of pipe in inches.

W = weight of steam in pounds

L = length of pipe in feet.

P = the difference between the initial pressure and final pressure at ends of main or total drop in pressure.

D = density or weight of steam per cubic foot at given initial pressure.

It is assumed that 1 sq. ft. of direct radiation under standard conditions will condense *0.3 lbs. of steam per hour, which is considered by many heating engineers as conservative and well within the limits of average practice, particularly where a good covering is applied to all mains, by which a saving of 80% of the heat otherwise lost is made.

$$(2)\ W = 0.3\ R \text{ per hour or } W = \frac{R}{3.33 \times 60}$$

$$\frac{R}{200} \text{ per minute.}$$

Substituting equation (2) in equation (1) and transposing we have

$$3)\ \frac{R^2 L}{P^D} = \left(\frac{200^2}{0.167^5}\right)\left(\frac{d^5}{1 + \frac{3.6}{d}}\right) = \left(\frac{200^2}{0.167^5}\right)$$

$$\left(\frac{d^6}{d + 3.6}\right) = (\log.\ 8.488480) \log\left(\frac{d^6}{d + 3.6}\right)$$

A convenient solution for equation (3) may be obtained by means of logarithms.

$$(4) \qquad 2 \log R + \log L + \log \frac{1}{P} + \log \frac{1}{D} =$$

$$(\log 8.488480) \log \left(\frac{d^6}{d + 3.6}\right)$$

or by using the accompanying tables in which all reasonable values have been computed. In place of the above variables in equation (4) we have

Table "A" + Table "B" + Table "C" + Table "D" = Table "E"

or one may select from Table "E" the largest commercial pipe size between which falls the summation of the values given in Tables "A," "B," "C" and "D," for the corresponding required conditions of the heating system.

DATA GIVEN IN THE TABLES.

In further explanation of the above, the tables give the values to be used which correspond to the required conditions and in the selection of the desired size of main. Thus: Table "A" gives the corresponding values for the maximum capacity of the main in square feet of direct radiation, Table "B" gives the corresponding values for the length of main or branch in feet, Table "C" gives the corresponding values for the drop in pressure in pounds per square inch, Table "D," the corresponding values for the initial or gauge pressure and Table "E" the corresponding values for the commercial pipe size.

The use of these tables does not require logarithms, steam tables or a long tedious process of solving a complex question.

HOW TO USE PIPE CHART.

The sizing of the various pipes for a steam heating system in large buildings is often done on the basis of a certain predetermined initial pressure and drop in pressure, using a length of run equal to the distance from the source or boiler to the farthest terminating point which is usually on the highest floor. For such conditions use may well be made of the accompanying chart.

As an example, assume 70,000 sq. ft. of radiation, 1,000 ft. run, 1 lb. drop and 3 lbs. initial gauge pressure. From the tables select from Table "A," opposite 70,000, the log 9.69; from Table "B," opposite 1,000, the log 3.00; from Table "C," opposite 1, the log 1.00; and finally from Table "D," opposite 3, the log 0.35. The summation of these logs is the log 14.04, and the nearest log selected from Table "E" is 14.16. Opposite this is the required pipe size, namely 14 ins.

Referring to the chart, follow the line extending at an angle of 45° from the pipe size, 14 ins., to the various intersections of this line with the vertical lines

*Including allowance for condensing capacity of distributing mains within the building.

denoting square feet of radiation. From these intersecting points are lines projected horizontally across the chart which indicate the required pipe size for the given conditions.

For example, follow the vertical line upward from 50,000 sq. ft. of radiation to its intersection with the 45° line extending from the point opposite 14 ins. The nearest horizontal line to the point of intersection is the one denoted by 12 ins., which is the size of pipe required to supply 50,000 sq. ft. of radiation for the same drop in pressure, initial gauge pressure, and length of run as assumed for the 14-in. pipe. In this way all mains, risers and branches for the heating system of a large building may be quickly and conveniently sized.

New Observations on Ventilation

According to orthodox views of architects, ventilating engineers and hygienists, as expressed by O. W. Griffith in an article in *The Medical Officer* (London), there are three points which must be strictly observed:

1. To provide sufficient cubical space per person, and a sufficient renewal of the air to insure its chemical purity.
2. To keep the temperature steady at about 60° F.
3. To keep the relative humidity at 75% or thereabouts.

Mr. Griffith was referring particularly to the conditions that would have to prevail in England after the present war, for he said, "when the young fellows in Kitchener's army return to civil life, they will demand healthier conditions than they formerly experienced in overheated factories and badly ventilated offices."

"Now these three cardinal points," added Mr. Griffith, "are shrouded in mystery, and though they are quoted in books on housing, ventilation, on hygiene and even on physics, one never finds a reference to any experimental facts in support of them, . . . Every attempt to discover poisons—organic or inorganic—in the air of occupied rooms under normal conditions has failed.

"As our experience widens, our knowledge of phenomena deepens, though now and again a genius appears before his time, has a vivid glimpse of the truth of things, and proclaims what he sees to an unheeding world. It is nearly a hundred years since Dr. Haberdeen—a medical man—in a short communication to the Royal Society, pointed out that the reading of an ordinary thermometer is no criterion of comfort, which really depends on the rate of cooling of the body. He advocated, as a test, warming the thermometer to about 100° F., and then determining the time of its cooling through one degree in the neighborhood of the temperature of the body. This rate of cooling he took to be the proper indication of the state of the atmosphere. His fellows gave his idea a decent burial in the transaction of the Royal Society —and his work was forgotten. But it has recently re-incarnated in the mind of Dr. Leonard Hill, who independently rediscovered it and extended it to the testing of the moisture in the air as well. The instrument adapted for this purpose is called the Kata-thermometer.*

"After a long and elaborate research conducted by Drs. Hill and Flack and myself, the complex part which temperature, humidity and movement of air play has been determined. Within a certain range, and keeping a proper balance between them, all three can be varied without affecting the pleasantness of the conditions. The movement of the air is, of course, more readily controlled than temperature and humidity, and that is really, I suppose, why the 60° F. and 75% humidity were fixed as standards. But it is important to notice that no combination of degrees of temperature and moisture can produce comfortable conditions in absolutely still air. Herein therefore comes the paramount importance of ventilation. Gentle varying air motion is stimulating to the skin—this is the prosaic physiological equivalent of the popular phrase: "Variety is the spice of life." On a beautiful spring or early summer day the radiant heat of the sun keeps the ground warm around our feet, and

*This instrument was described in the September, 1915, issue.

the soft, gentle, refreshing breezes circulates in eddies about the body, keeping the head cool and stimulating the nerve endings in the skin. These latter are like so many little telephone exchanges, which, when thus "rung up," call into vital activity all parts of the system. The kata-thermometer enables one to determine when this state of affairs obtains. It has the advantage that from its readings—taken in a few minutes—one can not only test the degree of comfort of the air, but one can also measure the humidity or the vapor pressure and the velocity of the eddies. For preserving and registering a continuous record of the comfort factor, Dr. Hill and the writer have invented an automatic electrical apparatus, called the Caleometer.

"Our observations show that to maintain the atmosphere of a room comfortable while the degree of moisture is going up—as it is liable to do when a number of persons are present—the temperature must be lowered, or the movement of the air increased. Since, however, overcrowding causes both moisture and temperature to increase, the necessity for more rapid air movement becomes greater.

"In the designing of houses therefore the size of the apartment must be such that a gentle air motion (as distinguished from an unpleasant draft) is sufficient to keep the air temperature and moisture from rising excessively and to preserve a standard kata-thermometer reading. To insure this the apartments must be roomy and lofty. The point, however, can only be settled by direct observation. The question of artificial heating complicates the matter enormously, but there are some points which the kata-thermometer has decided for us.

RATE OF COOLING SHOULD BE GREATER AT HEAD LEVEL THAN AT FLOOR LEVEL.

"It is absolutely essential that the rate of cooling should be greater at head level than at floor level. One of the chief disadvantages of the coal fire is that it sometimes inverts this arrangement. There is often a cold draft along the floor on account of the drawing power of the chimney. Draft excluders at the bottom of the door, or a small mat outside it, are the usual means adopted to cure this defect, and even when it is not completely eliminated, one can always keep comfortable by placing one's feet on the fender, so as to receive the full benefit of the radiation from the fire.

"In olden times the Chinese and the Romans kept their fire burning by a downward draft, and, I believe, the chimney passed under the floor. This, in principle, was an excellent arrangement. Heating by steam radiators (which are not radiators), and all similar ways of creating convected heat are thoroughly bad, because they produce slower cooling at head level as compared with foot level. Meanwhile we must rigorously test every new system and every new scheme. We must determine with precision the defects of the houses we have already got. The kata-thermometer helps to do this."

Can We Locate the Neutral Zone in Heated Buildings?

By J. J. Blackmore.

(Presented at the semi-annual meeting of The American Society of Heating and Ventilating Engineers, at Atlantic City, Sept. 16-17, 1915. The data in this paper formed the substance of a lecture in a course on heating and ventilating given by Arthur K. Ohmes to a class of Columbia University students.)

A study of the conditions created by the application of artificial heat to our buildings presents some very interesting and fascinating problems. Some of these problems are very elusive and not easily solved.

The conditions thus created, however, are due to the working of physical laws and if these laws are studied and understood, the reason for the changed conditions is readily appreciated.

The location of the neutral zone is one of these problems and its location is important on account of the many disturbances which may be created in the design and operation of heating and ventilating plants; especially is this the case in a large building of many stories in height.

PHYSICAL FACTS INVOLVED.

In cold weather, the air contained in a heated building, being of a higher temperature than the outside, is much lighter than the air surrounding it, and being lighter, it has a tendency to rise in accordance with the laws of gravitation. This body of light air is kept from rising by the walls and roof of the building, being thus prevented from rising, pressure is exerted against the ceiling and upper part of the walls to a considerable extent. In a large building, say 200 ft. by 200 ft. by 125 ft., containing 5,000,000 cu. ft., the difference between the weight of the inside air at 70° F., and the same quantity outside at zero is 5,000,000 $\times$ (0.0864 — 0.075) = 57,000 lbs. or 28.5 tons, 0.0864 being the weight in pounds of a cubic foot of dry air at zero temperature and 0.075 being the weight in pounds of a cubic foot of dry air at 70° F.

As an example, we will consider the conditions in a room as shown in Fig. 1, which is supposed to be air tight and uniformly heated to 70° F. when the outside air is at zero. The room having an opening at bottom the atmospheric pressure would be equalized at this opening.

The weight of a column of air one foot square and 50 ft. high at 70°, would be 50 $\times$ 0.075 = 3.75 lbs., and a similar column of air at zero would weigh 50 $\times$ 0.0864 = 4.32. The difference being 0.57 lbs. per square foot.

The warm air is, therefore, pressed

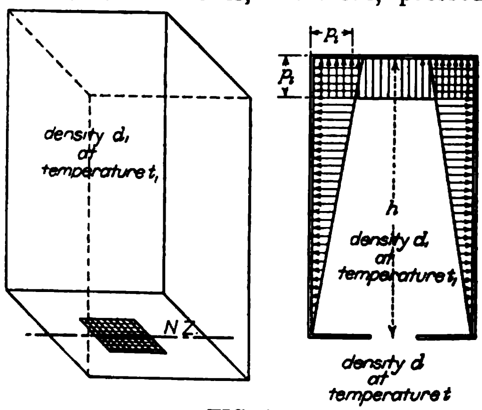


FIG. 1.

towards the ceiling by the greater density of the external air pressure exerted through the opening in the bottom of the room, the difference in weight or density of the two bodies is manifested by pressure against the ceiling and walls of the room. This difference of pressure would create a velocity equal to approximately 22 ft. per second, at the above temperatures. $V = \sqrt{\frac{2GP}{Y}}$ or $V = \sqrt{\frac{2 \times 32.16 \times 0.57}{0.075}} = 22$. In which G is the acceleration due to gravity, P the pressure in pounds per square foot, and Y the weight of a cubic foot of air at 70° F. in pounds.

COMPARISON WITH IMAGINARY U TUBE.

Comparison may be made between conditions in such a room and an imaginary U tube of large dimensions as shown in Fig. 2. Assuming that the U tube is 50 ft. high, filled on one side with

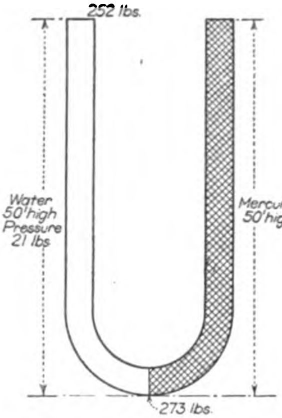


FIG. 2.

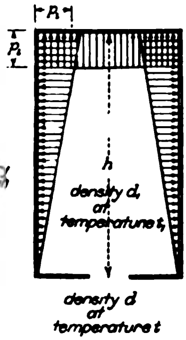


FIG. 3.

water and the upper end of the tube on that side is closed tight. Into the other side is introduced the same volume of mercury. The column of water 50 ft. high would exert a pressure of about 21 lbs., at the base of the tube, while the mercury would exert a pressure of 273 lbs., at the same point. In this case the pressure due to the mercury would force the water up against the closed end of the tube equal to a pressure of 273 — 21 = 252 lbs.

The different pressures in a room like that shown in Fig. 1 may be represented by the illustration Fig. 3, and the pressure at the top of this room as shown by the example of the U tube would be $Pi = h\ (d - d_1)$ in which

Pi = pressure above the atmosphere;
d = density of the outside air
d_1 = density of inside air.

Having in mind that one cubic foot of air at zero weighs 0.0864 lbs. per cubic foot and that for other temperatures the density of the air is in direct proportion to the absolute temperature, we can express the equation with approximate accuracy in temperatures to obtain the difference in density between equal volumes of the inside and outside air, as follows; for a room 50 ft. high.

$$Pi = h\left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right) \text{ or } Pi = 50$$

$$\left(\frac{0.0864 \times 460}{460 + 0}\right) - \left(\frac{0.0864 \times 460}{460 + 70}\right)$$

= 0.57 lbs. per square foot.

If this same room with the same conditions as before had one opening at the top instead of the bottom as in Fig. 4, and if the atmospheric pressure equalized with the room pressure, at this point, the difference in weight of the two columns of air would be the same as in the case with the opening at the bottom, but the external air, being heavier, would press on the under side of the room with greater force because the outside air is of greater density than that within. If an opening were made in the bottom, the room would appear to be under a vacuum, for the heavier air would at once flow through the opening into the room.

We have designated the pressure exerted against the inside walls as Pi, and in a similar manner we will designate the pressure against the outer surface of the walls as Pe, then the equation to

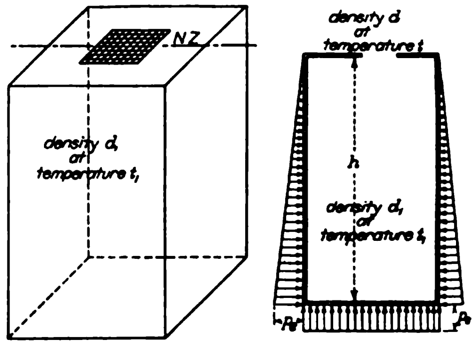


FIG. 4.

obtain the difference in weight or pressure by the density is:

$Pe = h\ (d - d_1)$, or to obtain it from the temperature it will be:

$$Pe = h\left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

The conditions illustrated in these two extreme examples show clearly the fact that different pressures above or below the outside pressures must exist

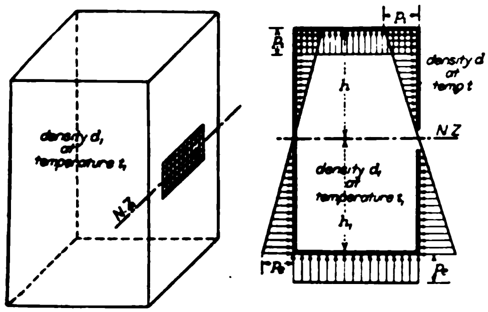


FIG. 5.

in a room or building when the contents are heated to a temperature above that of the external air.

In a similar manner if a room or building is cooled in the summer months the reverse of these conditions will obtain.

Additional openings into rooms will produce different conditions, also a change in the location of the openings into the room will shift the location of the neutral zone, as will be shown in the following examples.

In Fig. 5, with an opening in the side of the room the neutral zone will be slightly above the center of the opening and the following formula will apply:

$Pi = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

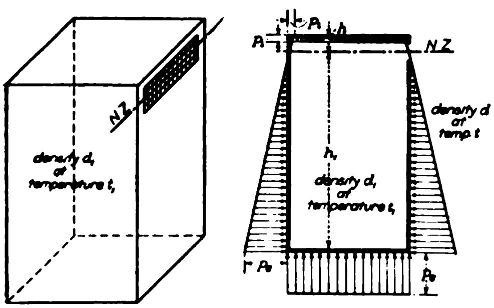


FIG. 6.

$$Pi = h_1 + h \left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

to obtain pressure by temperature.

$Pe = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

$$Pe = h_1 + h \left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

to obtain pressure by temperature.

EFFECT OF NEUTRAL ZONE IN TOILETS, KITCHENS, ETC.

Fig. 6 illustrates the location of the neutral zone as it would be in the case of toilets, kitchens, or other rooms generating odors which necessitate air opening for ventilation near the ceiling. In such a room a strong draft will be noticed when doors are opened into it. The same formula applies as given for Fig. 5.

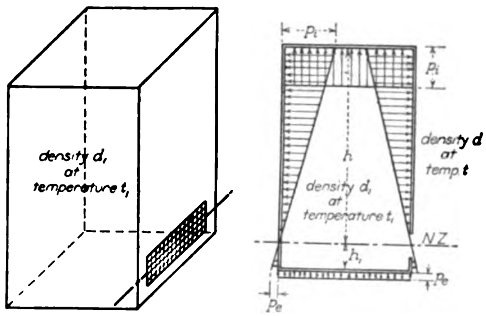


FIG. 7.

Fig. 7 illustrates the location of the zone in a room with an opening near the floor, as would be the case if a room was heated by the indirect method, if the register was located in a similar place. The opening of a door into such a room would occasion little, if any, draft. The same formula applies as given for Fig. 5.

Fig. 8 illustrates a room with an inlet and outlet which equalize the conditions and brings the zone to a point just above the center. Of course, an accelerated draft in the upper opening would raise

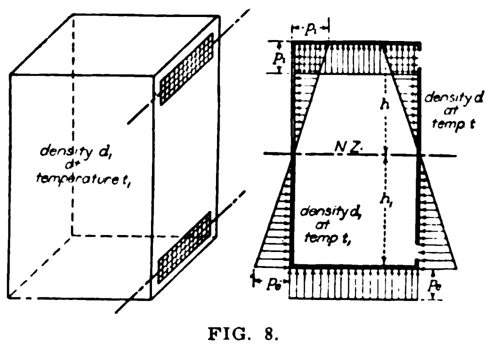


FIG. 8.

the zone to a higher plane and a partial closing of the same opening would lower it to balance the changed conditions. The same formula applies as given for Figure 5.

The foregoing figures illustrate the fact that the neutral zone may be located at any height in a closed air-tight room, by changing the position of an opening to the outer air. It is also possible to locate the neutral zone at a distance above the ceiling or below the floor of a room by an arrangement of outlets as shown in Figs. 9 and 10.

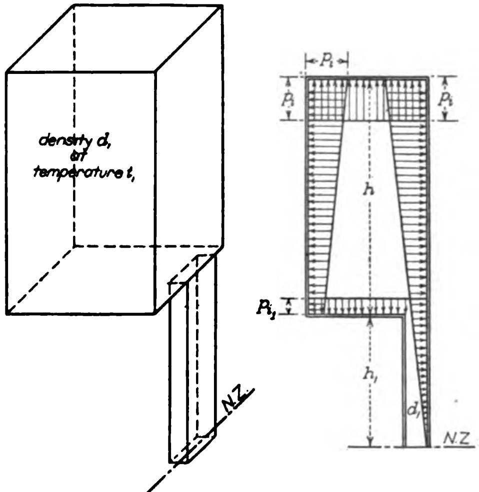


FIG. 9.

Fig. 9 illustrates a means of locating the zone at a point below the floor line. A floor register and a ventilating pipe with a strong draft would produce this condition:

$Pi = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

$$Pi = h_1 + h \left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

to obtain the pressure by temperature, being the pressure at ceiling line inside.

$Pi_1 = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

$$Pi_1 = h_1 + h \left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

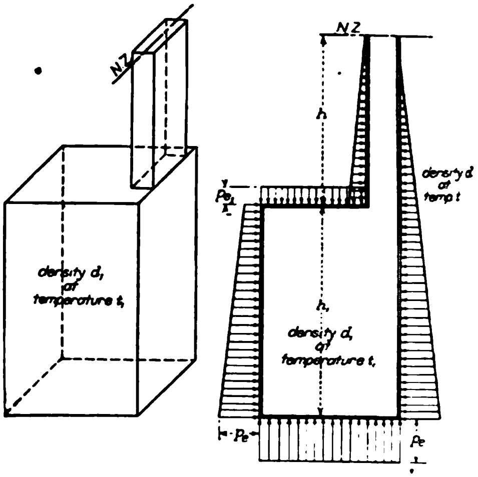


FIG. 10.

to obtain the pressure by temperature, being the pressure at floor line inside.

Fig. 10 illustrates a condition the reverse of those in Fig. 9, a ventilating pipe from the ceiling would lift the neutral zone to a point above the ceiling about as shown.

$Pe = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

$$Pe = h_1 + h \left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

to obtain pressure by temperature, being the pressure acting from the outside on the floor line.

$Pe_1 = h_1 + h\ (d - d_1)$ to obtain the pressure by density.

$Pe_1 = h_1 + h$

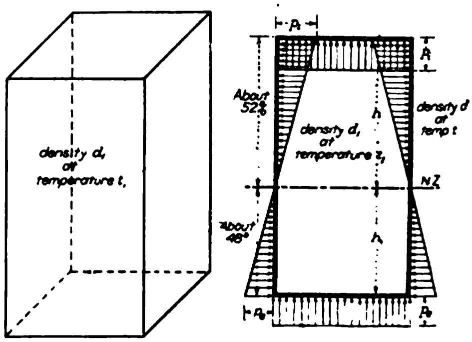


FIG. 11.

$$\left(\frac{0.0864 \times 460}{460 + t}\right) - \left(\frac{0.0864 \times 460}{460 + t_1}\right)$$

to obtain pressure by temperature, being the pressure acting from the outside on the ceiling line.

In an air tight room as shown in Fig. 11 the neutral zone would be 2% below the center, that is, it would be located at about 48% above the floor line.

EXAMPLES ALL BASED ON STILL AIR AND TIGHTLY-SEALED ENCLOSING SURFACES.

Again the author calls attention to the fact that all these examples are based on a condition of still air and tightly sealed enclosing surfaces, a condition which never exists in our buildings because the walls, ceilings and floors are porous and the windows and doors are surrounded by many cracks and crevices through which the air leaks in or is forced out, as may be determined by their location in relation to the neutral zone.

This condition may be explained as follows: There is always a place or plane inside a room or building that will be equal in pressure to that of the air surrounding it on the outside. This plane has been rightly called the "neutral zone." Its exact location in a room or building depends on the relative leakages at the ceiling or upper part of the walls or at the floor and lower part of the walls and under ordinary conditions in still air its location will be slightly below the central horizontal plane of the room. It will be understood, however, that if the lower portion of a building has more openings through which air can leak in than the upper portion, the zone would be raised somewhat higher and the reverse would be the case if more openings were located in the upper part.

No doubt the location of the neutral zone of an entire building will vary greatly with its size and shape, with the number and size of the windows and doors and their relative location, etc.

EFFECT OF SHAPES OF BUILDINGS ON NEUTRAL ZONE.

We will now consider the effect on the neutral zone of the shape of some noted buildings in New York City which, for the purpose of illustration, we will assume are all forty stories in height. The neutral zone will prove to be at an approximately different level for each building, if the location of it is figured from the foregoing data.

The location of the neutral zone in a building of the same floor area all the way up, as shown in Fig. 12, will be about the nineteenth floor. A building, as shown in Fig. 13, with a central tower above the twenty-fifth floor would have the neutral zone at a lower level, and in this case it would be somewhere about the sixteenth floor. A building, as shown in Fig. 14, with a tower above the eighteenth floor would have a still lower neutral zone, and in this case it would be approximately at the twelfth

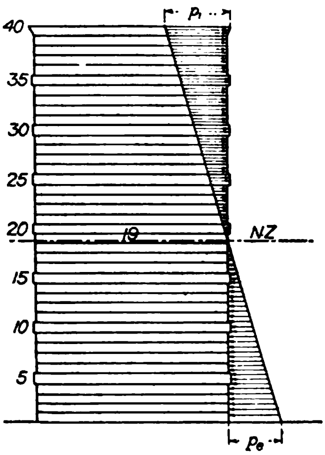


FIG. 12.

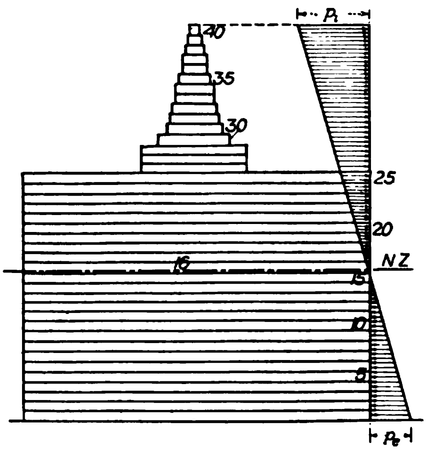


FIG. 13.

floor. In the case of the building illustrated in Fig. 15, which has a tower extending above the ninth floor, the neutral zone would be lowered to somewhere about the ninth floor, or practically at the roof line of the main building.

The practical importance of these illustrations would seem to be that they show that a rectangular or square building would have the greatest indraft and the least pressure at the top, whereas the tower building would have a less indraft per foot of surface, but a much greater pressure at the top of the tower.

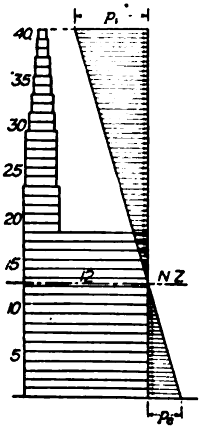


FIG. 14.

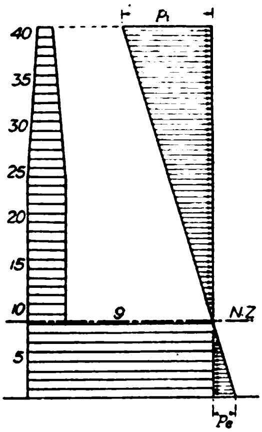


FIG. 15.

Anyone who has visited the top of a building like the Woolworth or Singer tower has probably noticed how difficult it is to close a door against the current of air flowing out from the top of such a building.

If we consider a tower building 750 ft. high and assume its neutral zone to be 300 ft. above the base, we would have (with a temperature of zero outside and 70° F. inside) an outside pressure of:

Pe = 300 (0.0864 — 0.075) = 3.42 lbs. per sq. ft. or 55 ft. per second, = 36 miles per hour and an inside pressure of:

Pe = 450 (0.0864 — 0.075) = 5.13 lbs. per sq. ft. or 66 ft. per second, = 45 miles per hour.

EFFECT OF HIGH WINDS ON INDOOR AIR PRESSURES.

Any high winds will effect these velocities as follows:

On the lower floors the leakages would be increased but on the upper the pressure would be counteracted because the tower presents a smaller surface to the wind.

It is, of course, understood that these studies on the subject of the neutral zone are considered with the building located in still air; wind velocities will change the location of the neutral zone, but such changes of location will not be material.

Poor or leaky construction in a building will materially affect the heat required to offset the loss occasioned by such construction, but such defects will not change to any great extent the location of the neutral zone. If more air leaks in below the neutral zone, a correspondingly larger amount will be forced out above the neutral zone.

Wind at a high velocity blowing against one side of a building may cause air to leak in to a larger extent on that side of the building on account of the excess pressure, in which case more air is forced out from the sheltered sides of the building which leaves the neutral zone not materially changed from what it would be in still air, but a larger amount of radiation would be needed on the windy side of the building to maintain a uniform temperature on the inside.

MORE RADIATION REQUIRED FOR SPACE BELOW NEUTRAL ZONE.

It will be seen from the foregoing that the radiation provided for the space below the neutral zone will need to be much in excess of that provided for the space above the neutral zone with a possible exception in the case of a top floor which is affected by the heat losses from the roof.

In a similar manner the neutral zone affects the ventilating system of a building. Its location determines the pressures in the building, and the pressures must be added or subtracted to or from the pressures under which the fans operate, whether the fans are placed in the basement or on the top floor of the building.

(*For discussion of this paper, see October,* 1915, *issue.*)

THE BUSINESS OUTLOOK.
II.

By Frank M. Huston,
Financial Editor of the Chicago Evening Post; Editor Rand-McNally Bankers' Monthly.

With the volume of our exports increasing by leaps and bounds and justifying an estimate by Washington of more than $3,716,200,000 for the fiscal year 1916 compared with $2,716,200,000 for 1915, there is ample assurance that there lies in this enormous strengthening of our financial position in the world's commerce sufficient reason for the expectation of a decided broadening in our industrial and commercial activity.

Already the barometer of industrial tendencies, the steel business has expanded to more than normal conditions. Mills are operating to a capacity beyond that regarded as possible prior to a few months ago. While the impetus for this broadening of activity came as a result of the abnormal export trade—orders for munitions and supplies made necessary by the war—yet our domestic steel business has returned to normal proportions, according to experts in that industry. The mills for weeks have been unable to take business for delivery during the early months of 1916, and the capacity of these big plants are being strained to the limit to care for business that is offering for the latter months of next year.

Money is accumulating so rapidly in our banks that it is becoming burdensome, and this excess of commercial funds and credit is already beginning to stimulate investment, despite the feeling of caution which the vast destruction of capital abroad in the war caused to manifest itself in the first year of the European conflict.

This country is forging to the front as the leading financial nation of the world. Today it is the center from which financial energy is spreading to Europe, and with the broadening tendency of economic power and civilization centering here the development of the next few years must necessarily afford an impetus for a broad expansion of business.

We are already lending credit to Europe, as is instanced by the credit loan of $500,000,000 to France and England. This is not a loan of money; it is in reality a loan of goods, such as grain and other foodstuffs and manufactured articles. It includes, of course, munitions, but Europe would have to buy munitions here whether we extended credit or not, but she might economize on many of her other purchases in this market and find other sources to supply her wants in the way of commodities other than munitions, were we to deny her the credit sought.

This extension of credit broadens our scope of activity. It gives our workingmen employment, our manufacturers a demand that is both profitable and stimulating. It is making this country, temporarily at least, the leader in the world's commerce, but it brings added responsibility, which will necessitate greater preparedness to protect our commerce and our business interests. All this means a broadening of industrial activity at home. It means additional buying power for the great industrial element of the country.

Nature has bestowed bountiful crops on our agricultural sections. One striking feature of this crop season had been the necessity of a progressive revision of estimates of our agricultural production. The latest available government estimates show, instead of a wheat crop slightly in excess of 900,000,000 bushels, the greatest wheat production in the history of any nation, a production in excess of 1,000,000,000 bushels. It shows a corn production nearly as great as that of 1912 and considerably in excess of 3,000,000,000 bushels. It shows a production of oats only slightly below a billion and a half bushels and other crops proportionately large.

Instead of our production of new wealth from the soil approximating around $10,000,000,000 it is necessary to revise these estimates because of the continuation of war prices for our surplus products. It is the demand for our surplus and the prices received for them that establishes the value of our crops, and there is reason to believe that an estimate of $11,000,000,000 for the new wealth created from the soil is not excessive. This means at least three times that amount of fresh credit.

Fundamental conditions were never better in this country for an expansion of trade and general business, the one retarding feature being the lack of confidence, which is attributable largely to uncertainty regarding the economic effect of war. But gradually the idea is gaining that the immediate effect of the war will not be as disturbing as the ultimate effect and that there will be an intervening period of great prosperity in this country. Soil conditions for next year are remarkably favorable. The soil is well soaked and any absence of rain is likely to be offset by the storage of moisture in the ground during the last two years.

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As BEARING directly on the movement for improving the status of the engineer, the frank statements, in another column, made by Ernest McCullough before the Western Society of Engineers, in a recent talk on engineering societies in general and their attitude towards the young engineer, are well worth reading. Passing by the criticisms leveled at many of the accepted society methods, there are some constructive suggestions regarding the needs of the young engineer. The young engineer, said the speaker, looks to his society for scholarship, companionship and definite recognition. He is glad to attend a meeting where there is a lack of formality and perhaps an opportunity to mingle freely with older men who have made their mark. He wants to make acquaintances with men having like interests with himself and to feel that the society is more than an editorial body or an encyclopedia compilation of engineering facts—that is, it is composed of flesh and blood men who want to help him because of their knowledge of the trials and tribulations he is undergoing.

Among the definite recommendations was one urging the establishment by engineering societies of "service clearing-houses." On this topic the speaker arraigned all of the older engineering bodies. He pictured the engineer as a wanderer from job to job. When capital is active he is hard to find, but when dull times come and capital rests, the streets are full of technically-trained men out of work. The speaker maintained that there is a place for all and that it is the duty of the older and more successful engineers to take care of those not so successful.

When it comes to legislation for the technical man, the speaker endorsed the proposition requiring the registration of technical engineers with an examining board qualified to examine men in different specialties, so that the word "engineer" will possess a dignity comparable with the titles of the other learned professions. He also urged a wider latitude in connection with publicity efforts. "Throughout his life," he claimed, "the technically-educated man, the engineer, is at times a professional man, a technical employee and a business man. He must do some publicity work, and a society should not be hide-bound in what is to be considered proper means of publicity to be employed by individual members." Another effect mentioned of proper publicity work was that it would have the effect of sifting out desirable men from those not so desirable, the speaker claiming that it is because of improper publicity work that there are so many complaints to-day of unfit men enrolled as engineers.

In short, as a plain talk on engineering societies, the address was about as breezy a presentation as one could hope to find.

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

53—Cause of Drop in Pressure in Pipes.

QUESTION: What causes the drop in pressure in a pipe conveying superheated steam, provided all the superheat is not lost when the steam reaches its destination? For instance, in a pipe carrying saturated steam the drop in pressure, we would say, was caused by the condensation or loss of latent heat; but in superheated steam, we have no loss of latent heat because it has not lost all of its superheat. Then what would cause the drop in pressure? This line is supposed to connect a boiler and engine.

ANSWER: The drop in pressure is due entirely to the velocity head and friction head whether the steam is superheated or saturated. The heat due to friction is all returned to the steam or, rather, there is no loss in heat content except from the radiation of the pipe. It should be treated as a gas or fluid flowing in a conduit.

The conditions of the steam at the end of the line is due to the loss of heat by radiation from the piping. If at the end of the line the heat remaining per pound is more than that of saturated steam at the final pressure, it is superheated; if it is less, the amount of steam condensed per pound will determine its quality or percentage of moisture.

As a rule, an approximate determination has to be made of the drop in pressure for a given discharge and size of pipe so as to find the average pressure in the run, to determine the weight per cubic foot to be used in the friction formula. The loss by radiation is determined, allowance being made for the efficiency of the covering, and the B.T.U. per pound of steam delivered due to the radiation loss. This is deducted from the B.T.U. per pound of steam at the initial pressure, which will give the B.T.U. per pound at the final pressure at the end of the line. Knowing the final pressure and the B.T.U. per pound, the condition of the steam can easily be determined from a steam table. In transmitting saturated steam, if the velocity is very high, with a great drop in pressure, the condition may be superheated at the end of the line in spite of radiation losses.

Where steam is condensed in a saturated line one-half the loss in B.T.U. is divided by the latent heat at the final pressure, as the capacity of the main is only reduced by one-half of the total amount. One-half of the radiation and condensation occurs before the one-half point in the main.

In long runs for heating mains it is often good practice to use a high pressure and small diameter main. With the high velocity and large drop in pressure the steam becomes superheated at the end of the main. This does away with any loss in condensation in transit and takes the place of a reducing valve at the power house as well as larger main under less pressure and drop.

The drop in pressure through the reducing valve is used for velocity in the first case. For example, we will assume a main 2,000 ft. long, 6 in. in diameter, and show what the discharge will be and its condition of pressure and temperature with an initial pressure of 75 lbs. gauge and 30 lbs. drop in pressure. We will then reduce the length of main to 200 ft. or 1/10th and determine the same points.

The loss in radiation will be, with 80% efficiency of covering and 3 B.T.U. per square foot per hour, with the ground temperature 40° F. and a steam temperature at the average pressure of 60 lbs. gauge. 6 in. pipe has 0.57 ft. of pipe per square foot of outside surface.

$$\frac{2000}{0.566} = 3530 \text{ sq. ft. surface.}$$

The temperature of steam at 60 lbs. gauge is 307.6° F.

$$\frac{3530 \times 3 \times (308 - 40)}{3600} = 800 \text{ B. T. U. per second, approximately.}$$

$800 \times 20\% = 160$ B.T.U. per second lost in heat from the main under the maintained condition of pressure and flow.

The formula for drop in pressure, from Meiers' "Mechanics of Heating and Ventilation," is:

$$P_f = \frac{W}{144}\ 0.0257\ \frac{V^{1.86}}{2\ g}\ \frac{1}{d^{1.3}}$$

In which

W = weight per cubic foot steam at the average pressure of 60 lbs. gauge.

V = velocity in feet per second.

P_f = friction loss in pounds per square inch.

2 G = 64.32 acceleration of gravity.

l = 2000 ft.

d = diameter in feet or 0.5.

We have now

$$30 = \frac{0.1721}{144} \times \frac{0.0257}{64.32} \times \frac{V^{1.86}}{(0.5)^{1.3}} \times 2000$$

clearing of arithmetical factors we have

$$V = \sqrt[1.86]{31411 \times (0.5)^{1.3}}$$

Log V = 2.1209466 = 132.1 ft. per second velocity.

The area of a 6-in. pipe = 29 sq. in. = 0.2 sq. ft. nearly. $132.1 \times 0.2 = 26.4$ cu. ft. of steam per second.

$$\text{Velocity head} = P_v = \frac{W}{144} \times \frac{V^2}{2g}$$

$P_v = (132.1)^2 \times 0.000018 = 0.31$ lbs. per square inch, which is negligible in this case.

The weight per cubic foot of steam for the discharge at 45 lbs. gauge pressure is 0.1394 lbs. per cubic foot. Then $26.4 \times 0.1394 = 3.68$ lbs. steam per second discharged.

$160 \div 3.7 = 43.2$ B.T.U. per pound of steam per second in radiation from the main. The total heat per pound of steam entering the main is:

At 75 lbs. gauge....1184 B.T.U. per pound.
At 45 lbs. gauge....1177 B.T.U. per pound.

Difference .... 7 B.T.U.

The latent heat at 45 lbs. gauge is 915 B.T.U. The per cent. of moisture in the steam will be as follows: $43.2 - 7 = 36.2$ B.T.U. condensed per pound. $36.2 \div 915 = 0.04$ lbs. of steam condensed per pound delivered.

As one-half of the steam is condensed at the center of the main and the other half at the end, there remains the same cubic feet and capacity of the steam condensed under the conditions named.

The actual per cent of moisture per pound will be $0.04 \div (1 + 0.02) = 0.0392$ lbs. moisture actually condensed per pound delivered. This will be of a quality of 96.08% at 45 lbs. pressure at the end of the line.

In case the pipe were 10,000 ft. long, the radiation would be five times more or 800 B.T.U. per second. Log V would be 1.762504 = 57.9 ft. per second. The area of the 6-in. pipe being 0.2 sq. ft., $57.9 \times 0.2 = 11.58$ cu. ft. steam per second.

Velocity head = $P_v = (57.9)^2 \times 0.000018 = 0.06$ lbs. The discharge at 45 lbs. pressure will be, at 0.1394 lbs. per cubic foot, $11.58 \times 0.1394 = 1.614$ lbs. per second.

The difference in heat per pound weight between the initial and final pressures, 75 lbs. and 45 lbs. gauge, is 7 B.T.U. per pound. The per cent. of moisture in the steam will be as follows, or the steam will be saturated with water as follows: 800 B.T.U. $\div$ 1.6 = 500 B.T.U. per pound. 500 B.T.U. — 7 = 493 B.T.U. per pound delivered. $493 \div 915 = 0.54$ condensed in pound per pound.

$0.54 \div 2 = 0.27$ lbs. of condensation. The percentage of water will then be $0.27 \div (1 + 0.27) = 21.3\%$ water. $21.3\% \times 1.614$ lbs. = 0.344 lbs. per second. The net discharge in saturated steam at 45 lbs. will be 1.27 lbs. per second.

If the pipe were 200 ft. long, instead of 2,000 ft., the radiation would be reduced by 10 or 16 B.T.U. per second per pound, instead of 160, as before. The velocity would be increased as follows: the factor in the former case, 31411, would become 314110. This is the only change, due to the length.

$$V = \sqrt[1.86]{314110 \times (0.5)^{1.3}}$$

Log V = 2.63377 = 430.3 ft. per second.
$430.3 \times 0.2 = 86.06$ cu. ft. per second.

The velocity head will be as before:

$P_v = (430)^2 \times 0.000018 = 3.33$ lbs., so that the drop will be increased by 3 lbs. for the above discharge, or 42 lbs. The weight per cubic foot at 42 lbs. pressure will be 0.1329 lbs.

86.06 cu. ft. $\times$ 0.1329 = 11.44 lbs. per second discharge at 42 lbs. pressure gauge.

The total heat at 75 lbs. pressure is....................1184.4 B.T.U.
The total heat at 42 lbs. pressure is....................1176 B.T.U.

Difference .... 8.4 B.T.U.

The loss per pound discharge per second will be, due to radiation of main, $11.44 \div 16 = 0.71$ B.T.U. per pound, with no condensation, as there are 8.4 B.T.U. per pound between 42 lbs. and 75 lbs. gauge.

The final condition of the steam will be 1184.4 — 0.71 = 11.83.7 B.T.U. per pound, which corresponds to 18° superheat at the end of the line.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Opening Meeting of New York Chapter.

A gratifying attendance marked the opening meeting for the Fall season of the New York Chapter, which was held October 18, at Keen's Chop House. The members were the guests of the chapter for the evening and the business was conducted over tables that were spread for the collation that came later.

The report of the Board of Governors stated that a resolution had been passed urging that the annual meeting of the society be postponed from January to May, partly on the ground of inclement weather likely to prevail during the winter time, and partly because it was felt that a larger attendance could be procured at the later date. The resolution was forwarded to the council of the society and the chapter was advised later that the council did not feel it could arrange for a postponement of the society meeting holding that such a matter should be acted on at a business meeting of the society. After a discussion of the matter, President Driscoll appointed a committee, consisting of Frank K. Chew, Homer Addams and George W. Knight, to draft an amendment to the society's constitution providing for the annual meeting in May. The treasurer's report showed a balance in the chapter's treasury of $400.

It was announced that J. I. Lyle had been appointed chairman of the chapter's entertainment committee which will act at the society's annual meeting. The chapter's committee on tests will be appointed later.

A motion was carried endorsing the proposition of amending the society's constitution and by-laws so as to simplify the election of new members.

Rawson W. Vail of the American Blower Company's export department was then introduced, his subject being "Export Engineering." Mr. Vail said that quality and merit are not the only considerations, but that attention to the ways and customs of business houses in foreign countries was equally important. Americans, he said, would consider the heating equipment of most European buildings as decidedly inadequate. The opportunities for foreign business, however, lie in the newer countries, such as those of South America, Australia, South Africa and Japan and, probably later, China. In these countries the railroad offices and school buildings are most in need of improved equipment.

Foreign engineers are only called in when the project cannot easily be handled locally. American heating engineering firms are not conspicuous as yet in these fields. As a way to get in touch with some of this work, Mr. Vail suggested that American contractors and engineers advertise in the South American trade papers.

Mr. Vail referred to the equipment of the Bureau of Printing and Engraving in Peking, a $1,000,000 building which has American mechanical equipment throughout. He also told of a large planing mill installation in South America which had attracted wide attention on the part of people living in that section.

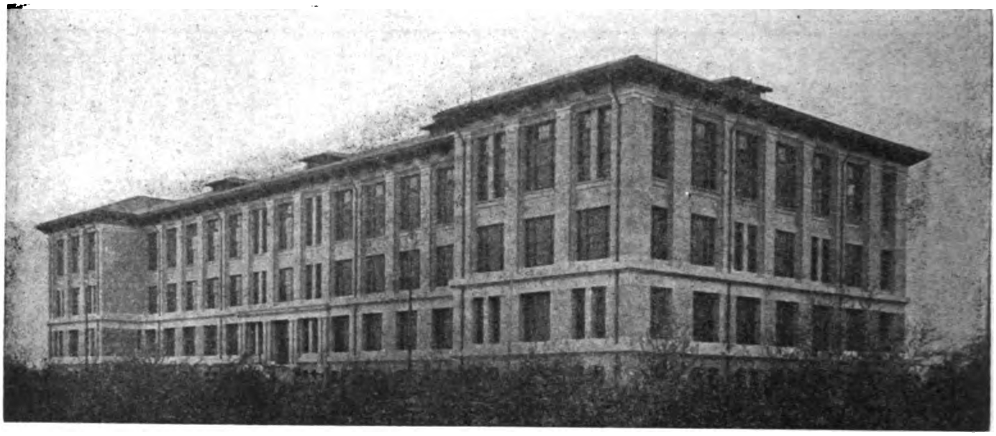
The main difference between export and domestic engineering, Mr. Vail said, was in connection with the system of units used, and it was necessary to become thoughly familiar with the metric system. Shippers must comply with the instructions given them in sending goods abroad, even to the color of the paper in which certain articles must be wrapped, as the natives get familiar with a certain color and insist on having it. Most of the engineering problems in these countries are now handled by European firms, but there are opportunities for American engineers, especially when it comes to the design of small power plants and all types of heating and ventilating work.

President Driscoll confirmed the speaker's last statement by relating a case that came to his attention in Chili where the design of a large power plant in connection with a copper refining project was given to an English firm, there being no applications from Americans for the work.

The next speaker was R. D. Hopkins, who spoke on "Engineering Work for the Chinese Government." Mr. Hopkins spent three years in Peking installing the mechanical equipment in the Bureau of Printing and Engraving building. Owing to the scarcity of skilled labor he was called upon to solve the unusual problems in connection with the installation work.

Mr. Hopkins said:

I suppose it would be appropriate for me to address you in Chinese, as the subject of



BUREAU OF ENGRAVING AND PRINTING, PEKING, CHINA.

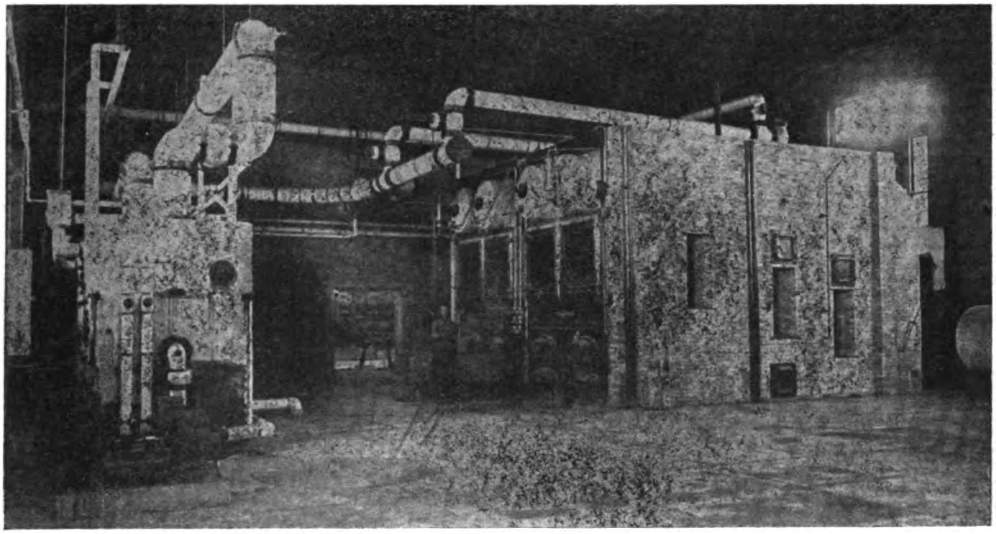
my talk will be engineering work in China. Therefore, I will say to you "How Ren, how bu how," which is the equivalent of "Good men, greetings to you." I highly appreciate this opportunity of being present as a guest of your chapter, and I will endeavor to interest you by telling of some of my experiences while installing the mechanical plant in the Chinese Government Bureau of Engraving and Printing at Peking, China, which comprises a group of buildings known as main building, power house and six officers' houses, pump house, etc.

The scope of the work included a complete power and lighting plant of two 250 H. P. B. & W. boilers; two 225 H. P. Harrisburg Corliss engines, each direct connected to a 150 K. W. Westinghouse direct-current generator; two 1,000 H. P. Cochrane feed water heaters and purifiers (the intention being to enlarge the boiler and engine capacity in the near future).

There are also two boiler feed pumps of the outside packed type; two electrically-driven volute sump pumps; two vacuum pumps for heating system; two steam air compressors for pneumatic temperature regulation; one 1,000 gal. Underwriter's fire pump.

There is a switchboard about 29 ft. long, having on it all of the latest switches,

VIEW TAKEN DURING CONSTRUCTION OF BUREAU OF ENGRAVING AND PRINTING.



BOILER ROOM, BUREAU OF ENGRAVING AND PRINTING.

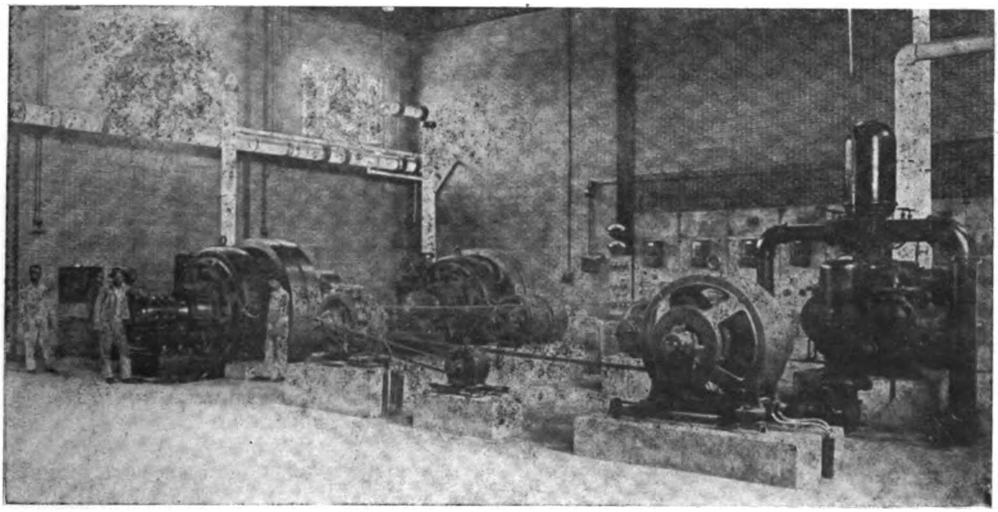
circuit breakers, meters, etc., in the field at the time the plant was designed

An arc lighting system was installed for illuminating the grounds, and for this there is a 50 H. P. motor driving a 50 lighting alternating set complete with 45 outside arc lamps swung from a harp shaped hanger at the top of steel poles 35 ft. high.

The direct current lighting for the buildings was installed on the three wire system from generators to switchboard, and two wires from switchboard to panel boxes; the current used for lighting is 110 volts across 220, and 220 volts for the power service.

EXHAUST STEAM HEATING USED.

The system of heating employed was exhaust steam with mechanical extraction having the usual by-pass and reducing valves from high pressure steam. Direct radiators were installed in all of the principal rooms of the main building and officers' houses, and a portion of the power house, such as ink mill, color mill and the laundry. The direct radiators used were of the H. B. Smith Company's make. Vento radiators were employed for the drying rooms, tempering and heating stacks for the ventilating system.



ENGINE ROOM, BUREAU OF ENGRAVING AND PRINTING.

The overhead feed system of steam supply was employed for the direct radiators, with returns in trenches under the basement floor.

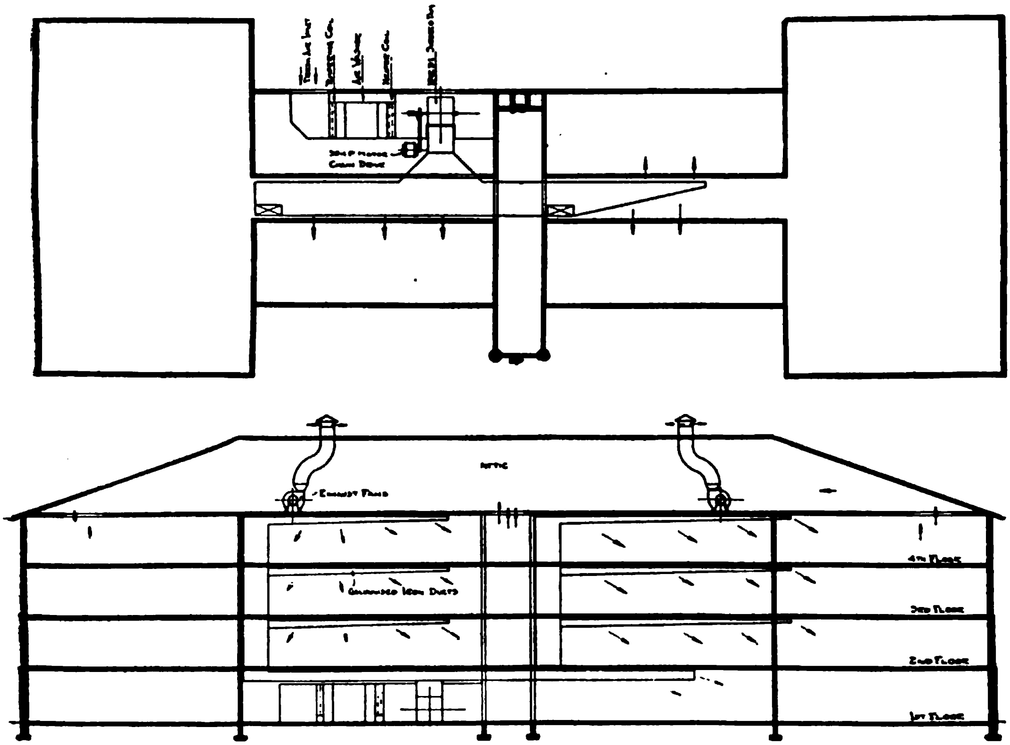
Fans and blowers were of the American Blower Company's manufacture; one No. 12 full housed double inlet blower and two No. 7 full-housed single and inlet exhausters, with three No. 2½ exhausters for special work. All of these fans were driven by motors.

We installed an underground system of steam and return pipes for the outlying buildings. These, together with the electric light and telephone wires, were run in water-proofed wood conduit made up on the premises by native labor. There is about 22,000 ft. of this material employed, ranging in size from 2 to 6 in. inside diameter.

The smoke breeching and smoke stack, the latter being 6 ft. in diameter and 150 ft. high, were built up in the field.

We also erected a 50,000 gal. anti-freezing water tower and tank over four artesian wells, 5 in. in diameter by 300 ft. deep. Over each well pipe we slipped a suction tube 3 ft. in diameter and 30 ft. long, into which the suction pipes from four electric triplex pumps were dropped, discharge from the pumps feeding the double tank. From this tank were run discharge pipes leading to the buildings for general supply and for fire service.

The method of erecting smoke stack and water tower would be considered quite unusual in this country. It was all done without the use of derricks, or engine hoist of any kind. A few sticks of timber and a couple of blocks and falls were the only thing used outside of the numerous Chinese coolies at the end of the rope.



PLAN AND ELEVATION, BUREAU OF ENGRAVING AND PRINTING, SHOWING HEATING AND VENTILATING SYSTEM.

A complete system of plumbing was installed of the same sort as is used here in New York, with hot and cold water supplies to all fixtures, which included bath tubs, water closets, urinals, showers, sinks, wash basins and wash troughs.

Separate sewers for house and rain water were installed which led to a sewer disposal plant and filtering beds.

A complete system of fire service piping was installed inside and outside of the buildings, with hose, racks and reels for the

buildings, and hydrants and hose carts for the outside.

Then we had inter-communicating telephone system with a 40 drop switchboard; a complete time-clock system, with master clock and twenty-four secondaries; a watchman's time detector system with twenty-four stations; a complete electric fire alarm system; temperature regulation for all principal rooms of the main building, power house and officers' houses, and an air washing and humidfying system; two Otis electric elevators with 10-ft. platforms; a complete system of ventilating ducts, conveying the air from the blower to the rooms and exhausting from the rooms to the exhaust fans with the usual registers, grills and dampers.

The labor employed was entirely Chinese, and the only assistance given me was an electrical engineer toward the latter part of my stay.

All pipe was worked on the job except the 10 and 12-in. which was cut to sketch from drawings made here in New York before my leaving. Some of the drawings were made here in New York a couple of months previous to my leaving, while the balance of them were completed in China. These drawings were used as working drawings from which we installed materials and I found it was necessary to employ a great deal of care in making these drawings so that the Chinese workmen could understand them.

EXPERIENCES WITH CHINESE LABOR.

One can well imagine how interesting it was to teach the Chinese to cut and thread pipe, put up a water-tube boiler, install the Corliss engine and generators, fans, plumbing fixtures, elevators, etc. The Chinese mechanics learn rapidly, and it was but a few months after I had schooled a picked few that we had a fairly good working gang, who were in turn taught by the first few so schooled.

Some of the best men were ordinary coolies taken from the fields, and this was accounted for by the fact that they knew nothing at all of mechanics and only did what they were taught to do. When a Chinese mechanic learns a thing a certain way it is very difficult to get him out of that way; but once he has learned a thing wrong it is equally hard to get him to do it right.

We had little trouble with leaky joints on the large pipe for the reason that they had so much labor at hand that they would employ a half dozen or more coolies on the end of a pair of chain tongs and rely upon the weight of numbers to make the joint tight. With small pipe, where there is no room for many coolies, we did experience a number of leaks.

The mechanic in charge is above exerting himself in the same order that the ordinary laborer would do.

The entire work was complete and operating before I left Peking.

The cost of labor varies somewhat with its class. A steam fitter is paid from $15 to $30 per month; a helper, $8 to $10 per month, while the coolie or laborer gets from $4.50 to $9 per month. These figures may seem very low, but as the labor is more deficient than efficient, the net result is nearly the same as we have in this country.

The cost of the entire installation was nearly $500,000, while the cost of labor amounted to about $40,000.

It required three years time to complete the work.

The buildings were designed by Messrs. Milburn & Heister Co., architects, of Washington, D. C., while the mechanical plant was laid out by Isaac Francis, of Philadelphia, Pa. The contract of installing the work was taken by Shewan Tomes & Co., of China and New York, by whom I was engaged to look after the actual work of installing. My duties covered everything that could possibly enter into a piece of work of this character, such as employing labor, listing and purchasing materials, getting materials through the Customs, having it carted to the building, storing it until it was needed, directing and superintending the actual putting in of almost every piece of pipe, every fitting and almost every detail of the work; making my own plans and blue prints, taking care of all correspondence, collecting and paying out the tunds and keeping a set of books.

The cost and comforts of living need not worry anybody that might contemplate going to China. The cost is considerably less than here, while the comforts are considerably greater, owing to the many servants one can have for the price of a single servant here. The house accommodations are, in Peking and other coast cities, very comfortable indeed, although they are not quite up to our standards here. We built our own house and small office building near the site of the work.

The usual method used by the Chinese in heating their home is to set a lighted charcoal brazier in the room. These braziers are made of sheet iron, lined with clay.

M. J. Sage, M. W. Franklin and W. L. Fleisher were elected to membership in the chapter.

The principal speaker at the November meeting will be George W. Martin, of the New York Service Company, who will speak on "Operating Costs." The meeting place will be decided later.

Illinois Chapter Elects Officers.

New officers were elected at the October meeting of the Illinois Chapter, held October 11, at the Morrison Hotel, Chicago. The meeting also discussed the matter of licensing ventilating contractors. The election resulted as follows: President, E. L. Hogan; vice-president, F. W. Powers; secretary, W. L. Bronaugh; treasurer, August Kehm. Board of governors: Charles F. Newport, H. M. Hart and S. R. Lewis.

In opening the discussion on the licensing of ventilating contractors, President Newport stated that the suggestion had come from Commissioner of Health Robertson of Chicago. The point was made by some of the speakers that the licensing of contractors in other trades had improved conditions. On the other hand, it was held by many that a more stringent ordinance was preferable to licensing. It is expected that the matter will be further discussed at a later meeting.

R. H. Lindman and S. A. West were elected to membership in the chapter, and John F. Hale was reinstated to full membership, which he relinquished while located in the East.

The next meeting of the chapter was announced for November 8, at the Morrison Hotel.

New Officers Nominated.

The following have been nominated for office in the American Society of Heating and Ventilating Engineers by the society's nominating committee:

For president, Harry M. Hart, Chicago; for first vice-president, Frank T. Chapman, New York; for second vice-president, Arthur K. Ohmes, New York; for treasurer, Homer Addams, New York. For members of the council: D. D. Kimball, New York; Henry C. Meyer, Jr., New York; Dr. E. V. Hill, Chicago; Frank Irving Cooper, Boston; Walter S. Timmis, New York; Charles R. Bishop, North Tonawanda, N. Y.; Fred R. Still, Detroit; and M. W. Franklin, East Orange, N. J.

The Society's Educational Committee.

In accordance with the resolution passed at the recent semi-annual meeting of the society, regarding the formulation of a plan to provide a society course of instruction in heating and ventilating engineering, President D. D. Kimball has appointed a committee which will have general charge of the matter and the different members will also act as chairmen of sub-committees. The committee is authorized to provide a report on the advisability of taking up the proposition of a lecture or educational course, such report to be presented at the annual meeting of the society. The following are the members of the committee and the special features each will take up: Chairman, M. W. Franklin; J. I. Lyle, scope of educational work; W. S. Timmis, publicity; W. W. Macon, faculty; Frank K. Chew, ethics and welfare; Homer Addams, finance; J. J. Blackmore, secretary to the committee.

NATIONAL DISTRICT HEATING ASSOCIATION

Convention Proceedings for 1915.

The proceedings of the 1915 convention of the National District Heating Association have been received by the members. It is stated that this is the earliest date the proceedings have ever been mailed following the convention. In addition to the papers and discussions, the volume contains a general index covering the years 1909 to 1915, inclusive, prepared by Messrs. Hecht, Orr and Spake of Chicago. It is intended later to publish this index with the list of members that will be issued early in the year.

The Association's New Bulletin.

The first issue of the new quarterly Bulletin of the National District Heating Association has made its appearance, being dated October, 1915. The Bulletin is of standard magazine size, and its arrangement and contents reflect much credit on the association and on those directly in charge. In addition to the contributed articles there are departments on "Operating Kinks," "Our Committees," "Vaporized News," "Question Box," "Legal and Commission Department," and "With Our Advertisers."

Under the committee heading, it is stated that the station operating committee will take up, among other things, the subjects of (1) oil as a fuel; (2) bleeder type of turbo-generator, and (3) operating data relative to a certain heating plant on which accurate information will be obtained by the committee through tests made by one of the member companies.

The question box is conducted by J. C. Hobbs, of the Duquesne Light Co., Pittsburgh.

Applications for membership, it is stated, have been received as follows since the Chicago convention: H. M. Byllesby & Co., Chicago; Grinnell Electric Heating Co., Grinnell, Ia.; Lewis Jones, Jr., Overbrook, Pa.; J. C. Butler, Illinois Maintenance Co., Chicago; University of California Library, Berkeley, Cal.; H. R. Wetherell, Peoria, Ill.; M. B. Skinner & Co., Chicago; George C. Daniels, Peoria, Ill.; C. S. Barnes, Boston; and the Central Asbestos & Magnesia Co., Chicago.

Plain Talk on Engineering Societies.

Some of the shortcomings of engineering societies in general, and of the older ones in particular, came in for a frank discussion in an address delivered by Ernest McCullough recently before the Western Society of Engineers.

Mr. McCullough's address was entitled "The Engineering Society." He reviewed the causes leading up to the formation of the American Association of Engineers and blamed the older societies for not giving more attention to the young engineer.

The technical or engineering societies have not developed with the work of the engineer, he said, and went on to add, as reported by *Power*, that these societies are still lingering in the past and consider themselves as institutions organized solely for educational purposes. This is the way they are conducted, but the majority of the members know many societies exist rather as an evidence of the standing of the members than for their declared purposes. The modern technical journal is doing far more real educational work than any society, no matter how large or how important it may be. The pages of the weekly and monthly papers bring to us news from the front, fresh and in a way that the more formal papers of a society cannot. The society proceedings have become mere encyclopedias, which are consulted less frequently than are the pages of the journals maintained purely for profit.

ENGINEERING BODIES TOO OFTEN MUTUAL-ADMIRATION SOCIETIES.

There is a well-founded idea that engineering societies have for many years past been mutual-admiration societies of successful men and have been used for the furthering of insidious advertising by men qualified to take full advantage of the position their membership brings them. The papers are generally obtained only by hard work on the part of the publication committee in each society. The discussions are too frequently inadequate, and real criticism is seldom developed when the author of the paper is of commanding eminence. The young man learns something, but not much, from the papers and feels diffident about discussing them, as he fears his opinion would not be well received.

NEEDS OF THE YOUNG ENGINEER.

The young engineer does not want this. He wants scholarship, companionship and definite recognition. He is glad to attend a meeting where he knows refreshments will be served, not because of the refreshments, but because something to eat and drink signifies a lack of formality and perhaps an opportunity to mingle freely with older men who have made their mark. He wants to make acquaintances with men having like interests with himself and to feel that the society is more than an editorial body or an encyclopedia compilation of engineering facts—that it is composed of flesh and blood men who want to help him because of their knowledge of the trials and tribulations he is undergoing. He would rather know how to obtain a position and how to hold it than to hear how other men have done engineering work, for he reads the technical journals and gets a surfeit of such material.

The author spoke briefly of the formation from time to time of societies organized by young men and intended to help them meet their particular troubles. In these organizations the employment question is uppermost, and while they may perhaps thrive while times are dull. they all fail when members have positions and forget to continue paying dues. This led up to a discussion of the object of the American Association of Engineers which was originated to raise the standard of ethics of the engineering profession and to promote the economic and social welfare of engineers. These objects are to be obtained by affording means for an interchange of information, by maintaining a service clearing-house, by affording patent and legal advice, by supervision of legislation and by proper publicity.

OLDER SOCIETIES NOT ATTENDING TO BUSINESS.

In analyzing the objects cited and the methods by which they were to be obtained and how they conflicted with the objects of the older associations, the author was of the opinion that the older societies were not attending to business. The work outlined should be attended to by the veteran. "Old men for council, young men for action," should be the motto of the older societies. If this were the motto and lived up to properly, the young men should obtain all the objects sought and the societies would grow

faster than they are now growing. The members should receive the worth of their money—the older men in the feeling of satisfaction following every worthy action, the younger men in the experience of material benefit.

Discussing the methods outlined, the older societies can honestly say only the first has been attempted by engineers—that of affording means for an interchange of information. That a service clearing-house has not been properly attempted is a reproach. The engineer is a wanderer from job to job. When capital is active he is hard to find. When dull times come and capital rests, the streets are full of technically trained men out of work. They wander from office to office, many of them starving and too proud to admit it, many never getting a substantial footing. Their work is concerned with new enterprises and with the day laborer they share the ups and downs of fortune. There is a place for all, and it is the duty of the older engineers to take care of their brothers. Every day the Western Society and the other large societies delay in organizing a service whereby members out of employment can be placed in positions is an inexcusable reproach. The organization is already formed. It requires only the spirit.

SOCIETIES SHOULD ACT AS EMPLOYMENT AGENCIES

Any society should not limit its efforts in this direction to members, but should give members the preference, all things being equal. All members needing men should file their wants with the secretary of the society and not attempt in any other way to secure men until the secretary says there are none available. All members might be classified by specialty and lists printed, so that those wishing to get in touch with men in any special line of work may have such a list given to them by the society and then make a choice.

The affording of patent and legal advice needs to be approached with care. The society should have an attorney who can help members that have trouble in collecting pay. That is, members who fall into the hands of unscrupulous employers.

LEGISLATION FOR THE TECHNICAL MAN.

The fourth method is concerned with legislation for the technical man. The architects are working hard to obtain legislation to make architecture a closed profession, beginning with the passage of the license law for architects in Illinois in 1897. A number of the States have similar laws, the greater number of which were passed during the present year. Engineers were opposed to legislation to license engineers, but conditions in the State of Illinois became so intolerable on account of the monopoly given to architects that the Western Society this year obtained the passage of a law to license structural engineers. This one thing has done more to help the society than any other single thing since it was organized. The next piece of legislation to be attended to is one fixing the status of sanitary engineers, or the plumbers will get ahead and obtain control of the design and construction of sanitary work. It is not the intention to make a closed profession of sanitary engineering, but to prevent injustice to such engineers because of legislation that may be secured in other lines of work, it will be necessary to have examinations and licenses for them.

WOULD REGISTER TECHNICAL ENGINEERS.

A better way would be to secure a law requiring the registration of technical engineers with an examining board qualified to examine men in different specialties, so that the word "engineer" will possess a dignity comparable with the titles of the other learned professions. Not only must the modern engineering society see that legislation is secured to protect and elevate the engineering profession, but it must also carefully look after proposed legislation to the end that no laws which work harm to the people of the State will get on the statute book. That is, as a citizen, the engineer must protect those that lack knowledge of technical affairs and are left at the mercy of special interests.

As to what is proper publicity depends upon changing ideas and advances in civilization. The advertising methods of the live, wide-awake business man may be considered coarse and unbecoming for the professional man. Is this idea a survival of a generation past? Is it, as many young men claim, a fetish worshiped by professional men for the purpose of helping older men maintain their preëminence and hold the young man back? The question must be answered individually just now. Throughout his life the technically educated man, the engineer, is at times a professional man, a technical employee and a business man. He must do some publicity work, and society should not be hidebound in what is to be considered proper means of publicity to be employed by individual members. It should be enough for the societies that the members remain decent and bring no discredit on the work of the technical men.

The societies heretofore have concerned

themselves with the publicity work of individuals. What is now a crying need is publicity work of the proper sort by the societies for the benefit of the membership and incidentally of the technically educated men not members of any society. Through proper publicity work all technical men not members will want to become members. Incidentally, the work of technical men will be so placed before the public that there will be an increase of good material in the ranks. Proper publicity should have the effect of sifting out desirable men from those not so desirable. It is because of improper publicity work that there are so many complaints today of too many unfit men enrolled as engineers. These men, no matter how unsuited they may be to the work of the engineer, have a place somewhere in the world where they can fit in, and it should be part of the duty of the engineering societies of the future to find the holes in which these misshapen pegs may fit.

Formula and Rules for Warm Air Heating.

An important publication has recently been issued by the National Warm Air Heating and Ventilating Association containing a carefully-compiled formula and rules for the installation of warm air heating apparatus.

The full rule for determining heat requirements is as follows:

In figuring the heat requirements of any given room in square inches pipe area, the following rules, which are easily understood and simple to use and work out, are recommended as rules which have given general satisfaction.

1. Find the total square feet of glass surface in windows and outside doors, taking the full opening measurements and counting outside doors as all glass; then measure the surface in exposed outside wall, from which subtract the glass surface; next reduce the wall surface to equivalent glass surface by dividing the net amount by:

10 if wall is 8 to 10 in. thick,
15 if wall is 12 to 26 in. thick,
20 if wall is 26 to 38 in. thick.

To this result, add the glass exposure; then as 1 sq. ft. of glass surface cools 75 cu. ft. of air per hour, multiply the total glass equivalent by 75, which will give the total cubic feet of air to be heated to offset the loss from glass and wall exposure. This total added to the cubical contents of space to be heated gives the amount of air to be heated.

2. For a temperature of 70° F. in zero weather, multiply the amount of air to be heated by 0.01222 [see note below (*)], and the result will be the heat requirements in square inches pipe area. For each degree below zero for which the heating is to be required, add 1% to the heat requirements.

This rule gives the total heat requirements of the room in square inches pipe area; and judgment must be used in increasing the number of square inches pipe area in the rooms on the cold side, exposed to the north and west, and reducing the number of square inches pipe area on the warm side; also making allowance for poorly constructed buildings, loose-fitting windows, etc.

Add the square inches pipe area of all the rooms and choose heater of such capacity, as the result indicates.

SHOWING RULE IN USE.

Problem—

What are the heat requirements in square inches pipe area of a room $12 \times 18 \times 9$ ft., with four windows, $3 \times 5\frac{1}{2}$ ft. each, with two outside walls 10 in. thick—heating required for 10° below zero?

Answer—

Square feet of glass surface, $3 \times 5\frac{1}{2} \times 4 = 66$.

Square feet of outside wall surface, $12 + 18 = 30 \times 9 = 270$.

Net wall surface exposed, $270 - 66 = 204$.

Equivalent glass surface in wall exposure, $204 \div 10 = 20$.

Amount of air cooled by glass and wall surface, $20 + 66 = 86 \times 75 = 6{,}450$.

Cubical contents of room $12 \times 18 \times 9$ ft. $= 1{,}944$.

Total cubic feet of air to be heated, $6{,}450 + 1{,}944 = 8{,}394$.

Heat requirements in square inches pipe area for zero weather, $8{,}394 \times 0.01222 = 102$.

Heat requirements for 10° below zero, $102 + 8 = 110$ sq. in. pipe area.

**Note*—The coefficient or factor 0.01222+, which we advise using, as per rule, is derived from the following formula:

$$\text{H. S.} = \frac{\text{H} \times 55 \times 144}{60 \times 3 \times 3{,}600} = 0.01222+.$$

In the above formula—

H. S. = area of heat stack in square inches.
H. = heat loss from room in B.T.U. per hour.
55 = number of degrees through which 1 cu. ft. of air can be heated by 1 B.T.U.
144 = number of square inches in 1 sq. ft.
60 = average difference in temperature between air leaving register and room temperature.

3 = average velocity in feet per second of air in heat stack to first floor rooms.
3,600 = number of seconds in 1 hour.

A SHORT RULE FOR SMALL ROOMS.

This is accompanied by a short rule for use in cases where installers do not wish to go through the detail of figuring the complete rule. This short rule is in the form of a table of warm air pipe diameters for residence heating and is intended to apply to rooms of less than 1,300 cu. ft. area, and using 8-in. pipe.

Contents, cu. ft.	One outside exposure.	Two outside exposures.
1,300 to 1,800	One 9" pipe	One 10" pipe
1,900 to 2,400	One 10" pipe	One 11" pipe
2,500 to 3,000	One 11" pipe	One 12" pipe
3,100 to 3,600	One 12" pipe	One 14" pipe
3,700 to 4,200	One 14" pipe	Two 11" pipes
4,300 to 4,800	Two 11" pipes	Two 12" pipes

For rooms with unusual exposures, figure one size larger pipe than called for in the above tables; for second and third floor rooms, one size smaller.

The booklet also contains rules for pipes; pipe and register sizes, including equivalent areas of round pipes, flat register pipes, risers and registers; table of average pipe sizes; wall pipe and fittings; directions and rules for cold air supply; fresh air room; chimney flues.

Fresh air rooms are strongly recommended as they provide, it is stated, for a far better control of wind currents. The recommendation is that they should be three times as large as the air supply and well insulated to prevent cooling from the floors above.

The following table is included on chimney flues:

Diameter, round chimney flue, inches.	Size, square chimney flue, inches.	Size, rectangular chimney flue, inches.	Height of chimney flue above grate, feet.
8	7½ × 7½	6×10	30
9	8½ × 8½	8×10	32
10	9½ × 9½	8×12	34
11	10½×10½	10×12	36
12	11½×11½	10×14	38
13	12½×12½	12×14	40
14	13½×13½	12×16	40
15	14½×14½	14×16	40
16	15½×15½	14×18	40
17	16½×16½	14×20	40
18	17½×17½	16×20	40
19	18½×18½	16×22	40
20	19½×19½	18×22	40

Effect of Wall Paper on Room Ventilation.

A writer in the Journal of Gas Lighting describes experiments made with a view to seeing whether the ventilation of rooms could be improved in any simple way. Originally, both experimental rooms had a light wall paper which had become somewhat dirty through lapse of time. Later the paper was stripped from one of the rooms and the walls whitewashed, and subsequently the other room was treated in the same way. The whitewashed walls naturally caused a considerable increase in the illumination on the table or desk in the room. The result of observations of the temperature, humidity, proportion of carbonic acid and ventilation of the papered and whitewashed rooms showed that the ventilation was 17% greater in the whitewashed room. On this account whitewash seems preferable, and the author sees no hygienic advantage in wall papering. The tabulated results show that the proportion of carbonic acid in the air of the room at the end of each test was appreciably lower with whitewashed than with papered walls.

Other parallel experiments were made to ascertain the effect of different methods of ventilation. One pair of experiments shows the effect of opening wide and closing the door once every half hour during a seven-hour period. The ventilation was improved about 10% by this periodical opening of the door. Other sets of tests compared the effect of taking the air supply to the gas stove from the corridor with taking it from the room itself. The supply of air to the gas stove from the room itself improved the ventilation by about 20%.

In other tests the effect of opening the window flap while the gas stove took its air supply from the room itself was tried, with the result that it was found that the ventilation was thus increased by 74%. Finally, a series of tests was made in which the vent pipe in the ceiling was opened. This was most effective, the ventilation being increased two and one-half to two and three-quarter times, and in one case even five times. Obviously, this increased ventilation must affect the humidity of, and proportion of carbonic acid in, the room. The author thinks, however, that these tests with the open vent pipe have not much practical significance, as there is usually no provision for ceiling ventilation in living rooms.

The autumn meeting of the (British) Institution of Heating and Ventilating Engineers was held in London, October 12, when papers were read by Walter Jones on "Heat Transmission and Heat Emission," and by Samuel Naylor on "A Comparison Between Forced Firing and Slow Combustion." A report was also presented on the research work at the University College which has been conducted by A. H. Barker.

Saving Fuel in Heating a House

With Results of a Test in a Connecticut Residence.

Exhaustive information on the various fuels used for heating residences, the factors governing the consumption of fuel and convenience of operation, together with general suggestions on the firing of different fuels, is contained in the report of a government investigation carried out by L. P. Breckenridge and S. B. Flagg. It is published as Technical Paper 97 of the Bureau of Mines, Department of the Interior.

It is stated at the outset that of the 570,048,125 tons of coal mined in one year in the United States, probably 10% to 15% went to purchasers who used it largely for heating dwellings. Facts are then given regarding wood, anthracite coal, bituminous coal, sub-bituminous coal, lignite, peat, coke, fuel oil, and gas; also the use of electricity for heating. The advantages and disadvantages of the various fuels are given as follows:

Under "Methods of Heating Residences," all of the modern systems are briefly described, with hints on the various factors affecting their design and governing the consumption of fuel. These hints cover such items as climate, size and type of dwelling, location of dwelling, life of heating apparatus and convenience of operation. Under "Size of Boiler and Furnace," it is stated that until the last five years both makers and buyers of house heating boilers and furnaces gave little thought to the fuel to be burned. In fact, the ratings now published for much of the heating equipment, it is stated, are based on the use of one of the large sizes of anthracite coal. Emphasis is laid on the depth of the fire pot which, where the full rated load is to be carried without attention to the fire for a minimum period of eight hours, should have a fuel bed at least 12 in. deep.

ONE SEASON'S OPERATION OF A RESIDENCE HEATING PLANT.

The publication concludes with interesting figures on the fuel consumed in heating the residence of Prof. E. H. Lockwood,

Fuel.	Advantages.	Disadvantages.
Wood..........	(a) Cleanliness, (b) cheerful fire, (c) quick increase of heat, (d) cheap in some localities.	(a) Low fuel value, (b) large storage space necessary, (c) labor in preparation, (d) scarcity, (e) does not hold fire long, (f) unsteady heat.
Anthracite.......	(a) Cleanliness, (b) easy control of fire, (c) easier to realize heat in coal than is the case with other coals, (d) steady heat.	(a) High price, (b) difficulty of obtaining, (c) slower response to change of drafts.
Bituminous coal.	(a) Low price, (b) availability, (c) high heat value (in the best grades), (d) low percentage of inert matter (in the best grades).	(a) Dirty, (b) smoke produced, (c) more attention to fire and furnace necessary than with anthracite.
Sub - bituminous coal and lignite.	(a) Relatively low price, (b) availability (in some regions), (c) responds quickly to opening of drafts.	(a) Slakes and deteriorates on exposure to air, (b) takes fire spontaneously in piles, (c) heat value generally low, (d) heat in fuel difficult to realize, (e) fires do not keep well, (f) gases generated over fire pot sometimes burn in smoke pipe, causing excessive heating.
Peat............	(a) In general, the same as for wood	(a) Low heat value, (b) bulkiness.
Coke............	(a) Cleanliness, (b) responds quickly to opening of drafts, (c) fairly high heat value.	(a) Bulkiness, (b) liability of fire going out if not properly handled, (c) fire requires rather frequent attention unless fire pot is deep.
Oil..............	(a) High heat value, (b) immediate increase of heat, (c) cleanliness, (d) small storage space necessary.	(a) High price, (b) difficulty of safe storage.
Gas..............	(a) Ease of control, (b) cleanliness, (c) convenience, (d) immediate increase of heat.	(a) High price in many places.
Electricity.......	(a) Every advantage............	(a) High price.

of the Sheffield Scientific School, Yale University, for the heating season of 1912-1913.

This residence is located at 52 Division Street, New Haven, Conn., and has a north and east exposure sheltered by trees, while on the west it is protected by a house 20 ft. distant. It is of frame construction, with clapboard on first floor, shingle on second floor and slate roof. There are two stories, also attic and cellar, containing in all ten rooms. The windows are of single glass, in good condition, with storm windows on the north side.

The dimensions of the rooms and the radiation installed are as follows:

Name of dealer— ...... Coal Co., New Haven, Conn.

In charge of furnace—Owner, aided by family.

Firing schedule in cold weather—Coal fired at 7:30 A. M., 8:30 A. M., 1 P. M., 6:30 P. M., and 10 P. M.

Automatic appliances—Clock to open pipe damper at 5:30 A. M. Used every night.

The furnace was started October 2, 1912, and the furnace fire ended May 22, 1913, although it was not going continuously after May 1. The furnace was, therefore, in operation 219 days, or 31.3 weeks, or 7.3 months.

DIMENSION OF ROOMS AND RADIATION INSTALLED.

Floor.	Room.	Floor space, feet.	Volume, cubic feet.	Amount of hot-water radiation installed, feet.
First	Parlor	13×14	1,300	52
	Dining	14×16	2,030	61
	Living	16×20	2,800	150
First and second	Hall	8×10	1,200	65
Second	Bedroom	12×14	1,320	31
	"	13×14	1,450	35
	"	11×11	980	22
	"	9×11	700	26
	Bathroom	6×8	400	13
Attic	Bedroom	10×12	850	26

The heating system is hot water, with direct radiation; the name of the heater is not given. It has, however, a fire pot 20 in. in diameter, and 2.2 sq. ft. of grate area. The radiators are of cast iron, some 19 in. high and some 33 in. high.

The actual total amount of hot water radiation is 481 sq. ft. Other details are:

(a) Exposed double-glass surface—130 sq. ft.

(b) Exposed single-glass surface—286 sq. ft.

(c) Exposed wall (plaster and clapboard) —1,750 sq. ft.

(d) Total volume of space heated—13,000 cu. ft.

Supplementary heating system—2 fireplaces, 1 in dining-room, 1 in living-room.

Wood burned in fireplaces—1 cord a year.

Kind of wood—Oak and maple, 2-ft. lengths.

Use of fireplaces—Dining-room fireplace used nearly every morning in cold weather for about 1 hour; other fireplace used less, more for cheerfulness than for heating.

FUEL AND METHOD OF FIRING.

Kind of fuel used—Yard pea (intermediate in size between washed pea and No. 1 buckwheat).

Cost of coal, delivered in bins—$4.25 per short ton (2,000 lbs.).

The total amount of coal burned during the season was 18,780 lbs., or 9.4 net tons, making the average weight of coal burned per day 86 lbs. The greatest weight of coal burned per day (for two days only, January 13 and February 6) was 160 lbs., while the smallest amount was 20 lbs. The maximum for any one week (February 7-13) was 960 lbs., and the minimum (April 23-30), 160 lbs. The average weight of coal burned per square foot of grate per hour on the coldest day was 3 lbs. The cost of coal for the furnace for the season was $40.00, the cost of wood for the fireplaces for the season, $8, making a total of $48.

TEMPERATURES AND CALCULATED RESULTS.

Average daily temperature inside for whole season, assumed .... 69° F.

Average daily temperature inside during coldest week assumed .... 66° F.

Average daily temperature outside for 219 days, October 2, 1912, to May 22, 1913, from records of New Haven Weather Bureau .... 41.5° F.

Same for coldest week of Winter, February 7-13, 1913 .... 20.7° F.

Constants used for obtaining heat loss from house:

(a) Double glass per square foot per hour .... 0.46 B.T.U.

(b) Single glass, per square foot per hour .... 1.08 B.T.U.

(c) Walls (plaster and clapboard)... 0.44 B.T.U.

Calorific value of coal was not determined, but from analysis of washed pea sold in New Haven, it was estimated at .... 12,500 B.T.U.

Heat loss from house, figured from items 23, 50, 51, 52, 53, 54, average from October 2, 1912, to May 22, 1913, per hour ....31,000 B.T.U.
Same, average during coldest week from February 7-13, 1913, per hour.......50,800 B.T.U.
Heat theoretically available in fuel, figured from items 41, 44, 55 (assuming 1 cord of wood equal to ¼ ton of coal):
(a) Average from October 2, to May 22, per hour..................47,500 B.T.U.
(b) Average during coldest week, February 7-13, 1913, per hour.75,800 B.T.U.
Average furnace efficiency, figured from items 56, 57, 58a 58b:
(a) For 219 days, October 2, 1912, to May 22, 1913 ....65%
(b) For coldest week, February 7-13, 1913 ....67%

MISCELLANEOUS REMARKS.

Number of years same furnace has been used with this fuel by present owner—Five years.
Experience of owner—All rooms can be kept comfortable (70° F.) in coldest weather, except 2 rooms (items 8 and 12). These rooms have insufficient radiation and can not be heated above about 65° F. in coldest weather.
Use of rooms—All rooms in the house have been used continuously and heated during entire winter.
Capacity of heater—Has been ample to supply hot water at all times.

The coal was weighed by means of a 25-lb. spring balance, which was hung from a bracket on the side of the coal bin. Coal was shoveled into an ordinary scuttle holding 20 lbs. net, and after weighing was dumped into a supply box holding 40 lbs.

The report is characterized as "showing not only a low cost of heating, but also an economical use of fuel and illustrates what savings may be effected when the problem is given proper consideration. Yard pea could be used because the heater was large enough to burn the coal, even in the coldest weather, at a low rate of combustion per square foot of grate area. Systematic and regular handling of the fire doubtless had considerable to do with the results obtained. The cost of heating is probably $50 to $100 less than what is expended by a large number of householders who live in the same locality and have about the same heating requirements, but use more expensive fuel and give their heating equipment less attention."

A Case of "Natural" Heating.

Nature is a kind mother, full of wonderful inventions, but to hear that she can heat a whole hospital with hot water in an installation of pipes without the aid of fire of any kind seems almost too marvelous to be true. Yet at Acqui, in Italy, the large modern building which has hitherto been used for the Communal Schools, and has now been turned into a hospital where some hundreds of wounded soldiers are housed and tended by French nursing sisters, has a system of hot water pipes entirely supplied from the celebrated boiling spring in the centre of the little town, a natural source which yields 118 gal. of hot water per minute at a temperature of 165°. Further, all the water used in the hospital for washing and cleaning purposes comes straight from that wonderful well, so there is no need of fires or furnace, and no expense in fuel—a welcome economy in war time, when coal and coke have risen in price.—*Domestic Engineering (London).*

CORRESPONDENCE

Determining Butt and Lap-Welded Pipe.

EDITOR HEATING AND VENTILATING MAGAZINE:

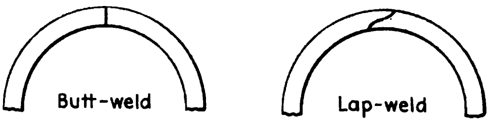
Will you kindly inform me as to the best practical way of determining whether pipe is lap-welded or butt-welded? I should like to know if it is possible to do this without resorting to chemical means, and also, what is the method of conducting the chemical analysis? E. A. L.

Westmount, October, 1915.

REPLY BY F. N. SPELLER, METALLURGICAL ENGINEER FOR THE NATIONAL TUBE COMPANY.

The following method of determining whether pipe is lap-welded or butt-welded is the most satisfactory, as it requires only one chemical:

First cut a transverse section from the pipe in question, and smooth one end of it on an emery wheel or with a file. The end should then be polished with fine emery paper until all scratches, which might be



CONSTRUCTION OF BUTT AND LAP-WELDED PIPE.

confused with the weld, are removed. This polished annular surface is now dipped into a shallow vessel containing a 10 to 15% solution of sulphuric acid, somewhat warmed. It would be well to note that care must be exercised in mixing concentrated sulphuric acid and water, always pouring the acid into the water while stirring constantly. Considerable heat is generated, which may crack the container if made of heavy glass or porcelain. A glass laboratory beaker is most satisfactory.

The acid will gradually etch the polished surface, giving it a uniform grayish color, except at the weld, where a fine black line

will gradually appear. Usually only a few minutes are required for this operation, but the time will vary greatly with the temperature and strength of the solution.

The two sketches shown below indicate the general appearance of the two welds:

The line in the butt-weld is usually straight, while in lap-weld it is curved.

A good non-chemical method of differentiating pipe welds consists in driving a round wedge or drift into one end of the pipe until it fails. Lap-weld pipe will not always open at the weld under this treatment, but in nearly every case butt-weld will open in such a way as to show very definitely the nature and position of the weld.

If the weld is visible on the outside of the pipe, it may be forced open by crushing down in a vise or hammer, being careful to place the weld on the side so that it will be under the greatest strain.

Neither of the last two methods are as satisfactory as the first one, but are usually sufficient if the investigator has had a little experience.

There is no "chemical analysis" method of determining the nature of the weld.

Mechanical Features of the Panama-Pacific International Exposition.

By Guy L. Bayley.

(From a paper presented at the San Francisco meeting of the American Society of Mechanical Engineers.)

With three large electric companies in the field, each capable of supplying needs of the Panama-Pacific International Exposition, at San Francisco, the necessity for building a power plant was not considered. The Pacific Gas and Electric Company, which furnishes electric energy to the exposition, has a substation on the grounds, and the interesting feature of a power plant in operation is supplied by the Sierra and San Francisco Power Company, whose 18,000-kw. plant is located within the grounds, about 500 ft. east of the Palace of Machinery. This plant is operated in conjunction with a hydroelectric system for supplying energy to the United Railroads, and is an excellent example of a standby station with steam turbines and oil-fired boilers. Under an arrangement with the Pacific Gas and Electric Company, this steam plant is kept in operation continuously, so that in the event of an interruption in the regular source of supply it will carry the load of the exposition.

With the exception of the spaces occupied as offices, no heating was provided for the main exhibit buildings other than the Service Building, Administration Building, Press Building, Festival Hall, Palace of Horticulture and the Auditorium at the Civic Center.

GAS-FIRED AIR HEATERS USED IN FESTIVAL HALL.

The heating of Festival Hall is a departure from standard practice in that a system was installed using gas-fired hot-air heaters with forced circulation. While gas at 75 cents per 1,000 cu. ft. is an expensive fuel, its use for the short period of the exposition was justified by the saving in the initial cost of the plant as compared with a steam plant. The heaters and supply fans are located in two rooms, one on each side of the main auditorium. Each fan room contains two steel plate fans, each having a capacity of 1,500 cu. ft. per min., and four hot-air furnaces, each capable of burning 440 cu. ft. of gas per hour. The arrangement is such that one fan serves two heaters and delivers air through registers located in the columns around the main entrance, while the other fan discharges into a plenum chamber beneath the raised side seats, openings being provided in the risers for the discharge of air into the auditorium. Air is removed from the auditorium by two multi-blade exhaust fans installed beneath and on each side of the stage, and having a combined capacity of 5,200 cu. ft. per min. All fans are belt-driven by direct current motors equipped with armature control.

In the California building, the administration quarters are heated by 8,700 sq. ft. of direct radiation with vacuum returns. Steam for the heating system and for the hot-water supply and kitchen equipment is supplied by two oil-fired, cast-iron boilers operated at a pressure of 5 lbs. Ventilation for the ball-room is secured by two 60-in. disc fans located in the attic space.

To provide the necessary heat in the dome portion of the Palace of Horticulture, which is essentially a large conservatory, a hot-water system with forced circulation was adopted. The hot water is supplied from a model boiler plant located about 90 ft. south of the main building, in which are installed two oil-fired cast-iron boilers equipped with vertical, rotary burners. Owing to the architectural requirements of the neighborhood, it was undesirable to use a tall stack, and smokeless combustion has been secured with a stack which is only 30 ft. high from the burners and terminates in the staff basket. Forced hot-water circulation is produced by two centrifugal pumps designed to operate against a head of 40 ft., each direct-connected to a 7½-h.p. induction motor. Re-

cording thermometers and a flow meter enable accurate records to be kept of the amount of heat delivered by the plant.

The heating required for the section beneath the dome was calculated on the basis of 3,725,000 cu. ft. of space, 54,650 sq. ft. of glass surface, and 15,470 sq. ft. of wall surface. It was assumed that there would be one complete change of air every three hours and a loss of six B.T.U. per hour per square foot of wall surface and 17 B.T.U. per hour per square foot of glass surface, making—a total of 1,376,800 B.T.U. required per hour to maintain a temperature of 50°F., with an outside temperature of 35°. The four rooms adjoining the dome section were figured for temperatures from 60° to 80°F., which brought the total requirements of the building to 3,582,000 B.T.U. per hour, requiring the circulation of 190,000 lbs. of water per hour, with an initial temperature of 250° and a loss of 20°. Radiators of the cast-iron type were used instead of the customary pipe coils, with satisfactory results. Thermostatic control was installed in several of the rooms for regulating the temperature of ponds. The plan of using forced circulation and high temperatures made possible a material reduction in the size of the mains and the quantity of radiation required.

Minor heating installations were provided in various buildings, such as the Service Building, which is heated by direct steam radiation of the single-pipe system, while the Press Building is heated by the Rector system, which burns gas in connection with cast-iron radiator elements, the products of combustion being removed by means of a fan located in the basement. The offices in the exposition palaces and most of the buildings erected by participants are heated by gas radiators or gas stoves of the radiant type, flues being provided to carry away the products of combustion.

Owing to the fact that the Auditorium in the Civic Center is a permanent, four-story-fire-proof building, a modern heating and ventilating system was installed. In order that the main hall might be used for dances and other functions, a system of heating and ventilation was adopted which left the floor free of obstructions. Fresh air is forced through the openings in the balcony risers and grilles along the face of the balcony. The grilles are supplied with separate ducts, whereas the openings in the risers receive their supply from a plenum space beneath the balcony seats. Exhaust fans are provided to remove the air through smaller grille plates above the balcony and just below the base of the auditorium dome.

For supplying fresh air, two fans are installed in the basement, each having a capacity of 145,000 cu. ft. per minute. Two main exhaust fans, each capable of handling 70,000 cu. ft. per minute are installed in the attic, and two exhaust fans of 75,000 cu. ft. per minute capacity in the basement. Additional supply and exhaust fans are provided for the banquet rooms, toilets and kitchens, these fans having a total rating of 39,000 cu. ft. per minute. The fans, of which there are 18, and the vacuum pumps, are belt-driven by motors aggregating some 250 h.p. Heating coils are used in connection with the various fresh-air supply fans, and provision has been left for air washers, should they ever be found necessary. Direct radiation is used for the upper corridors, convention halls and offices.

The Coming Use of Bituminous Coal.

The United States today furnishes about 40% of the coal mined in the world. Our hard coal will last us, we are told, about 100 years, provided our present rate of consumption is continued. The supply of soft coal, the experts agree, will last at least a thousand years at the present rate.

Anthracite coal becomes more valuable if left in the ground. Each year the price always goes up and the more you leave the more you will sell by and by. On the other hand, bituminous coal is being mined more freely, so it is evident we must burn bituminous coal.

Each inhabitant had generated for him about four times as much power in 1910 as in 1870; in other words, we are becoming an industrial nation and the reason that we have the smoke problem with us is because of the fact that we are continually using more and more coal.

A letter from the Chicago Smoke Department the other day said. "We have not accomplished all we thought we could ten years ago, but still we have done a good deal. While we are giving attention to one kind of thing, we find we are getting into trouble with all this residence work. I think you will be glad to know that two or three of the very largest companies that furnish heating appliances for homes have spent in the last few years a great many thousands of dollars, and have had two or three experts employed all the time trying to produce heating boilers that would operate at low rates of combustion and not make smoke, and that their efforts have been successful."

Last month I saw a boiler suitable for heating residences, containing 1,500 sq. ft. of radiation, into which was fired at one

time 350 pounds of Illinois coal. Smoke of about No. 3 grade issued from the stack for only three minutes, and then for three hours and a quarter no smoke at all. In other words, there are furnaces today that will operate with attention from a janitor, perhaps once in four hours, that will burn very poor grades of coal and not smoke. I think that the manufacturers themselves realize that the next demand will be for smokeless boilers for small heating jobs. It may be from 20 to 150 horsepower on the horsepower basis, or heating buildings containing from 1,000 to 15,000 sq. ft. of radiation.—*L. P. Brechenridge, before the Cleveland Engineering Society.*

University Laboratories May Assist Business.

An effort to get the universities of the country to handle specific problems for the industries by experiments or otherwise, is being made by the Chamber of Commerce of the United States. At a recent meeting of the directors it was voted to refer the matter of co-operation between the universities and representative business establishments to the chamber's committee on education or to a special committee and it was further ordered that the subject be taken up with the educational institutions for the purpose of ascertaining the extent to which these institutions may be interested.

At present large industries such as glass making, food, steel and drug manufacturing are connected by very slight threads with the great universities or with the government, except as the government exercises police supervision over the products of the business industries.

In addition to the plan for having the universities make particular investigations, it is suggested that the universities might be induced to organize a course of study, training the students along particular lines that would be of direct benefit to the industries. The understanding would be, in this case, that these manufacturers would be willing eventually to take the most desirable of these students into their plants for the working out of the future scientific development and the problems of manufacture.

Cleveland Contractors' Stand Against Free Engineering.

The full text of the resolution passed by the Cleveland Association of Master Steam and Hot Water Fitters regarding the preparations of plans for heating systems, passed October 1, states that:

Whereas, The members of this association are frequently called upon to estimate the cost of heating systems for buildings, for which no heating plans have been drawn, such practice entailing an undue expense upon its members, inasmuch as several plans are thus prepared for each installation where but one is necessary, thus causing, in the aggregate, a considerable economic loss; and

"Whereas, In many cases where the radiator and pipe sizes are shown, the heating contractor is required to guarantee the amount of radiation to be adequate to meet certain temperature requirements;

"Therefore, Be it resolved, that the members of this association refrain from bidding upon the installation of mechanical heating and ventilating systems, and of all direct radiation systems where more than ten radiators are to be installed, unless a complete plan and specification for same is furnished; and be it

"Resolved, that in the case of the installation of such heating systems, the architect or engineer having specified the amount, kind and location of radiation, he shall assume the responsibility for its capacity; and be it further

"Resolved, that when members of this association are required to prepare plans and specifications of any heating or ventilating system, they shall be reimbursed for such service at the rate of 3 per cent. of the cost of the installation, with a minimum charge of $10.00, unless the member preparing the plans and specifications should be awarded the contract for the installation, in which case such charge shall be omitted."

It is stated that many architects and engineers customarily furnish clear, complete, fair and ably-constructed plans and specifications, but that there are other architects and engineers who, when calling for bids upon the installation of a mechanical, or direct radiation system, furnish the heating contractor with a set of the general building drawings and expect him to design a heating system, including size, location and design of radiators, size and location of piping, size of boiler and all other essential features of the system. This being done, the heating contractor is expected to write a specification, make his estimate of the cost of construction and submit his proposal, accompanied by the plans and specifications which he has prepared. Thus, in the case of the average job, from six to a dozen plans and specifications are prepared, with the opportunity for but one to be utilized.

As a result it is claimed that the heating contractor must do much engineering work for which he cannot expect to receive any direct remuneration.

Annual Meeting of Eastern Supply Association.

The Eastern Supply Association held its annual meeting in New York, October 20, when the following officers were elected:

President, L. O. Koven, L. O. Koven & Brother, New York; first vice-president, G. R. Adams, Samuel Sloan & Co., Rochester, N. Y.; second vice-president, Joseph F. Evans, Wyoming Valley Supply Co., Wilkes-Barre, Pa.; treasurer, Martin Behrer, Behrer & Co., New York; secretary, Frank S. Hanley, New York.

Board of Directors: Above officers and W. L. Blake, W. L. Blake & Co., Portland, Me.; James F. Conran, Standard Sanitary Mfg. Co., Pittsburgh, Pa.; J. P. McPhail, James Robertson Mfg. Co., Baltimore, Md.; John A. Murray, John A. Murray Co., New York; F. T. Stevens, Plimpton & Hills Corporation, Hartford, Conn.; H. W. Thorndike, F. W. Webb Mfg. Co., Boston; and A. A. Tomlinson, Virginia-Carolina Supply Co., Norfolk, Va.

The following were elected members of the national committee: A. M. Maddock, Trenton, N. J.; Philip Speakman, Wilmington, Del.; F. W. Hubbard, Boston, Mass.; S. E. Hunting, Rochester, N. Y., and Walter Walls, Philadelphia.

Representative to the National Chamber of Commerce: P. M. Beecher, Syracuse, N. Y.

Addresses were made by Joseph F. Evans of the Wyoming Valley Supply & Mfg. Co., of Wilkes-Barre, Pa., on "Trade Loyalty," and by G. R. Adams of Samuel Sloan & Co., Rochester, N. Y., on "Better Business Building Blocks." After a discussion of the question, "Is it advisable or desirable for both manufacturer and jobber to have the manufacturer make prices to the jobber carrying a discount of 6 or 7 per cent. for payments ten days from date of invoice?" it was voted to have a committee canvas both manufacturers and jobbers on the advisability of having both branches of the trade co-operate in establishing such a rate of discount. Other speakers were H. H. Sommer, of the American Plumbing Mfg. Co., Brooklyn, N. Y., who urged the elimination of items from estimates; and J. B. Chambers, treasurer of the Pierce, Butler & Pierce Mfg. Corporation, and of the Kellogg-Mackay Co., who read a paper on "Reciprocating Credit Reporting," suggesting the establishment of an association bureau for the exchange of credit information.

The election to membership was announced of the McNab & Harlin Mfg. Co., New York; Republic Iron & Steel Co., Pittsburgh, and the Walworth Mfg. Co., Boston.

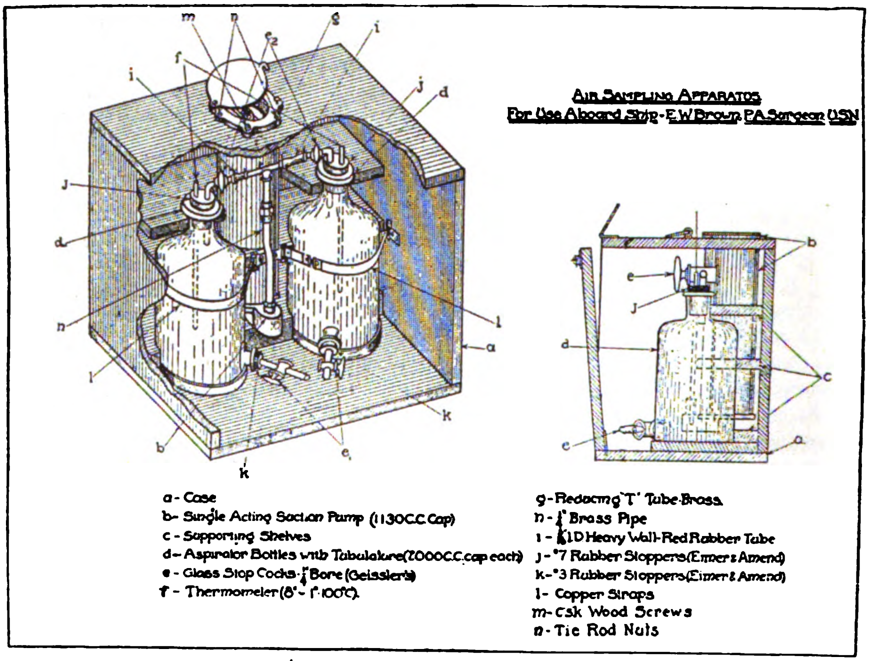
NEW DEVICES

A Portable Air Sampling Apparatus for the Collection of Large Volumes.

The apparatus here described has been designed for the rapid collection in duplicate of relatively large volumes of air to be examined in the laboratory for such gases as carbon monoxide, hydrogen sulphide, oxides of nitrogen, etc. Minute amounts of these gases are of hygienic significance when standard methods of analysis require the aspiration of large quantities of such air through appropriate absorbents. It is not practicable, as a rule, to make the analysis on the spot, particularly if the air is rapidly changing in composition, owing to the time required for aspiration and the special apparatus necessary to complete the analysis. A situation might arise, for example, in a sewer or in an engine room, when it is imperative to take large samples speedily so that a representative portion within a short-time interval may be obtained. The advantages of collection in duplicate are obvious. The present apparatus is designed to fulfill such requirements.

The apparatus is portable, protected against breakage under shipment, and airtight. It consists of a wooden case, 17 in. long, 12 in. deep and 14½ in. high, enclosing two glass bottles each of 2,000 cc. capacity, with gas-tight stopcocks, and fitted with a standard thermometer. The bottles are connected by glass and metal tubes with the inlet of a brass suction pump of special design. The writer has determined on the basis of a large number of tests that each stroke of the suction pump draws about 800 cc. of air through the two bottles at the rate of about one stroke per second. This was observed by connecting the two lower stopcocks to a gas holder and exhausting a definite quantity of air from the latter through the bottles with the pump. The course of the air in sampling is as follows: Through stopcocks e 1 to bottles, through stopcocks e 2 to the reducing T-tube g to h and to pump. The bottles rest on felt pads and are held firmly in place by copper straps encased in felt. The rubber stop-

pers are carefully wired in place. The pump is readily accessible for interior inspection. There is an outside carrying case provided for shipment, not shown in the sketch. This has a protective arrangement of springs at the bottom and also on the under side of the cover; the sides, cover and bottom are covered with very hard felt padding. The inside case is, therefore, guarded against any sudden jar in handling and no further packing material is needed. Thorough tests for tightness were made. There may be, of course, marked changes in pressure of the contained sample as a result of temperature variations; thus, a drop from 70° F. to 32° F. would entail a fall in pressure of over 2 in. of mercury. The apparatus remained perfectly tight under a positive and negative pressure of 6 in. of mercury, which is far in excess of any possible fluctuation.



PORTABLE AIR SAMPLING APPARATUS.

DIRECTIONS FOR SAMPLING.

Open stopcocks e 1 and e 2; give 20 strokes to the pump, and close all stopcocks securely. If it is desired to sample from a place where it is impracticable to place the instrument, carry rubber tubing connections from stopcocks e 1 to the location specified.

PRECAUTIONS.

Securely wire all stoppers to tubulatures of bottles; lubricate all stopcocks, and secure with rubber bands; wire all rubber tubing connections; inspect interior of pump from time to time as to condition of valves.

The following question arises: How many strokes of the pump are necessary to obtain a representative sample of air? The combined volume of the two bottles is 4,000 cc., and the air displacement of the pump is 800 cc.; thus, in five strokes, 4,000 cc. of air would pass through the apparatus, but the sample would still be contaminated by a small residual portion of the original air. This question was tested by the following procedure: The sampling bottles were connected through stopcocks e 1 by rubber tubing of ¼-in. internal diameter, with two openings into the interior of an air-tight respiration chamber of 300 ft. capacity, the CO_2 content of which had been previously determined by a Haldane gas analysis apparatus. A sample was then drawn from the chamber into the two bottles, using a definite number of strokes with the pump, the stopcocks then closed and CO_2 estimated in each bottle by the Haldane apparatus. The CO_2 percentage of the room and the number of strokes of the pump were varied from time to time. The data in the following table are typical of the results obtained. Each percentage

represents an average of three analyses agreeing within 0.02%.

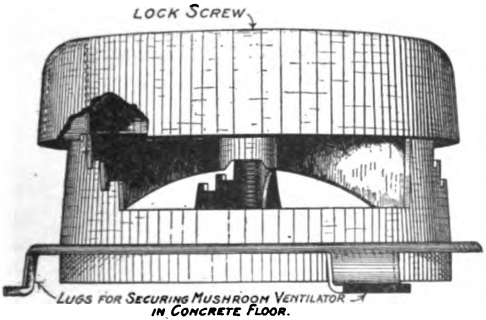
It is concluded from the accompanying figures that a minimum of 15 strokes of the pump are required to obtain a representative sample; but 20 to 25 strokes are recommended to allow a proper margin of safety.

Air-tight room, avg. CO_2, per cent.	Bottle 1, avg. CO_2, per cent.	Bottle 2, avg. CO_2, per cent.	No. strokes of pump.
0.78	0.73	0.74	10
0.24	0.18	0.20	10
0.24	0.20	0.20	10
0.26	0.20	0.21	10
0.26	0.19	0.20	10
0.52	0.47	0.45	10
0.80	0.81	0.79	15
0.57	0.56	0.56	15
0.23	0.21	0.21	15
0.24	0.23	0.22	15
0.27	0.25	0.24	15
0.24	0.22	0.23	15
0.25	0.25	0.27	15
0.27	0.26	0.25	15
0.25	0.25	0.25	15

—*E. W. Brown, Past Assistant Surgeon, U. S. Navy, in the American Public Health Association's "Journal."*

Trade Literature.

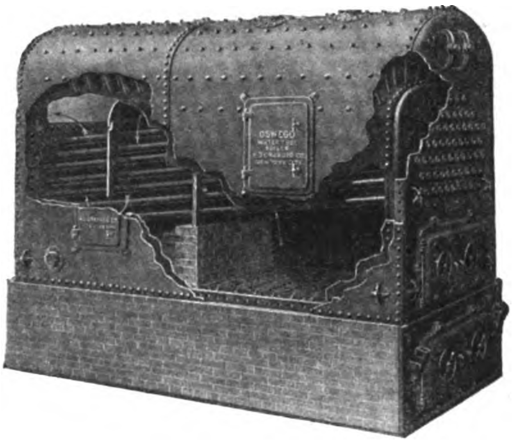
Perfect Ventilation Through Distribution, featuring the Knowles mushroom diffuser and air controlling head, is brought to the attention of the trade through a timely circular illustrating and describing the various types of this air diffuser. A notable list is given of the buildings in which the Knowles



CONSTRUCTION OF KNOWLES MUSHROOM VENTILATOR FOR USE ON CEMENT FLOORS.

device has been installed. A suggestion is also included for using the Knowles mushroom air diffusers in ventilating a motion picture theatre. This device, which is intended to be placed directly underneath the seats in a hall or auditorium, may be used with equal effectiveness with up-draft or down draft. The Knowles Mushroom Ventilator Company, 9 Church Street, New York, manufacturer of the devices, announces that it has just perfected a new method of securing the air diffuser to cement floors. Instead of the screw-eye lugs which are ordinarily used on wood floors, cast-iron projections have been provided from the floor flange extending down 1 in., so that, when set, the top dressing of cement will cover the same, making a simple, but solid, connection. Size of catalogue 3½ x 6½ in. Pp. 16.

Oswego Internally Fired Water Tube Boilers, made by the A. D. Granger Company, 90 West Street, New York, are the sub-

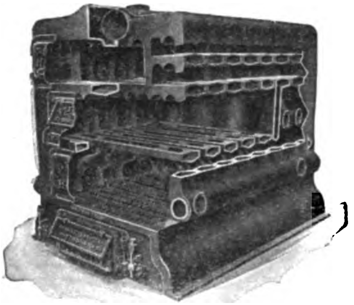


OSWEGO WATER TUBE BOILER.

ject of a newly-issued catalogue. It is stated that the boiler occupies the smallest space per horsepower of any boiler built, that it will show a maximum fuel economy, that no case of failure has ever been recorded or known, and that it is a rapid steamer. The inner and outer shell form a complete water jacket surrounding the fire, absorbing the radiant heat and eliminating the loss of heat in the brickwork of a brick-set boiler. The front and back water spaces are connected by straight inclined tubes so that the circulation is from the coolest to the hottest portion of the boiler. These tubes can be drawn forward when being renewed, into the firing space, so that no additional length to the rear of the boiler is required for this purpose. The company's line includes twenty-two types, ranging from 20 H.P. to 300 H.P. The high pressure line includes those built for a working pressure of 100 lbs. or over. The low pressure or steam heating boilers include all boilers for a working pressure up to 66 lbs. per sq. in., although the test pressure for all boilers of this class is 100 lbs.

Attention is called to the low water line of these boilers, the boilers being especially designed for use with gravity systems. The Oswego boiler is also made with Dutch oven settings, with the combustion chamber arranged for bituminous coal, or oil fuel, and for either hand firing or mechanical stokers. Down-draft water grates are also supplied for smokeless combustion of fuel. Size 8 x 10½ in. Pp. 14.

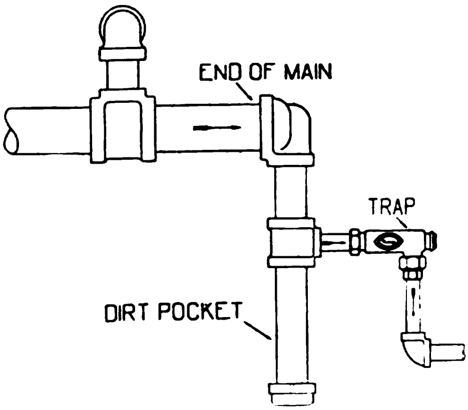
Peerless Patented Steam and Water Boilers, known for their patented S-shaped water tubes or braces and for the cup-shaped design of their crown plates which are designed to add to their heat efficiency and quick steaming qualities, are the subject of a well-prepared catalogue issued by the Peerless Heater Company, Pittsburgh, Pa. The crown plate is made up of sixteen 3-in. cup-shaped or hemispherical arches, resulting in a notable increase of heating surface without increas-



PEERLESS HEATER.

ing the volume of water to be heated. In connection with the S-tube feature of the water tubes or braces it is pointed out that they are so made, with a reverse curve, to avoid failure due to the strains incident to expansion when hot. In addition to its regular line, the company offers a line of smokeless boilers of the same general design, but equipped with down-draft water grates in addition to which is embodied the patented S-arm interior construction. The catalogue concludes with some noteworthy testimonials from satisfied users. Size 6 x 9 in. (standard). Pp. 40. Supplementing the catalogue, the company is sending out a test sheet giving details of a 24-hr. test on a Peerless down-draft smokeless boiler, conducted by Champlain L. Riley, of Clark, MacMullen & Riley, consulting engineers, New York, which showed, among other things, an efficiency of 67.9%, a water evaporation per pound of dry coal of 8.75 lbs. and an equivalent evaporation from and at 212° F. per pound of dry coal of 10.2 lbs.

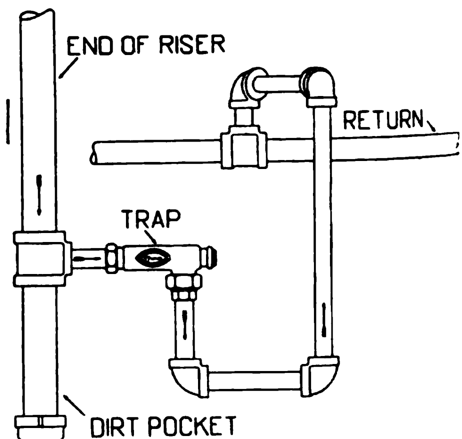
Winn Low Pressure Expansion Steam Trap and Its Application is the subject of a



APPLICATION OF WINN TRAP DRAINING END OF STEAM MAIN.

recent bulletin received from the Shaw-Kendall Engineering Co., Toledo, O. In its general construction the trap follows the lines of the Winn radiator trap, which was illustrated in our columns for May, 1915. The low pressure trap is designed especially to meet the demands where large volumes of water and air are to be taken care of. The expansion element is longer than in the radiator trap, giving a larger clearance through the valve opening. The inlet of trap, also, is directly opposite to that of the radiator trap, the expansion element closing off against the flow of the steam, instead of with it, which has been found the best method when used for dripping mains, steam risers, indirects, fan blast coils, etc. Size 6 x 9 in. (standard). Pp. 4.

Sturtevant Turbo-Undergrate Blower, to increase the furnace draft and permit cheaper coal to be used, is brought to the attention



APPLICATION OF WINN TRAP DRAINING RISER.

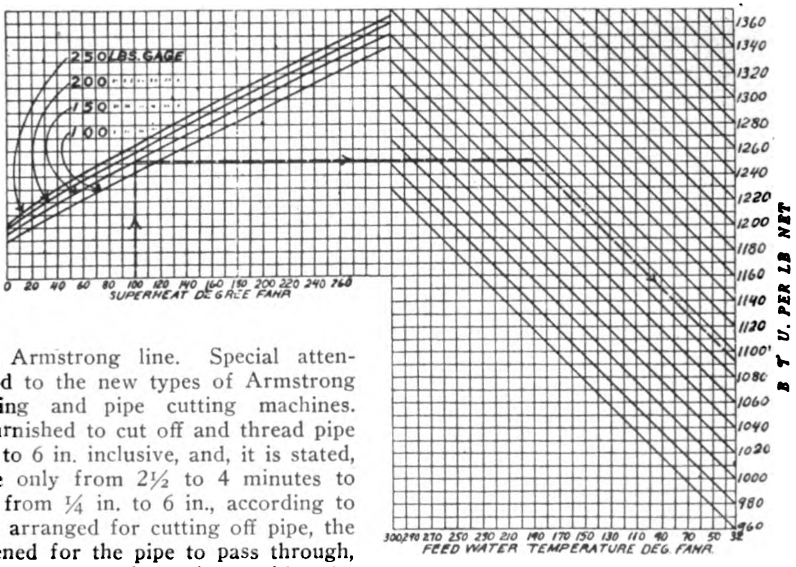
of the trade in a new circular published by the B. F. Sturtevant Co., Hyde Park, Mass. Where additional boiler capacity is contemplated, the turbo-undergrate blower is especially valuable as it may make additional boilers unnecessary, while at the same time it can be equipped with more steam nozzles should the work become heavier or the steam pressure less.

THE PITOT TUBE AND FAN TESTING, which was referred to in a number of recent discussions at meetings of the Heating Engineers' Society, has been issued as a second edition of Bulletin 35, Series 1, by the American Blower Company, Detroit, Mich. In addition to describing the development and testing of "ABC" Pitot tubes, the bulletin contains much valuable information regarding other Pitot tubes and meters, and also methods of conducting fan tests. This is followed by data showing the calculations that are necessary, the latter being supplemented by air and psychrometric charts and tables. Size 7½ x 11 in. Pp. 32.

GENUINE ARMSTRONG STOCKS AND DIES, water, gas and steam fitters' tools and pipe threading machines, manufactured by the Armstrong Mfg. Co., Bridgeport, Conn., are the subject of a new catalogue devoted to the well-known Armstrong line. Special attention is called to the new types of Armstrong pipe threading and pipe cutting machines. They are furnished to cut off and thread pipe from ¼ in. to 6 in. inclusive, and, it is stated, they require only from 2½ to 4 minutes to thread pipe from ¼ in. to 6 in., according to size. When arranged for cutting off pipe, the dies are opened for the pipe to pass through, without being removed from the machine, by a motion of the hand wheel or lever. The gears and bearings are enclosed in an oil chamber, thus preventing chips or dirt from getting into the working parts. A newly-patented attachment is included in several of the types whereby the cutting off of pipe is done automatically. Size 6 x 9 in. (standard). Pp. 56.

C. & C. MOTORS, made by the C. & C. Electric & Mfg. Co., Garwood, N. J., are featured in new circular matter illustrating the lower section of New York, and entitled, "The most remarkable group of buildings in the world is equipped with the old reliable C. & C. motors." It is also stated that C. & C. motors aggregating a total of 2,650 H. P. are installed for driving air compressors, pumps and blowers in the New York subway, East River tunnel and Hudson River tunnels. The circular contains a double-page photographic view of the Grand Central Terminal in New York, where 122 C. & C. motors aggregating over 5,000 H. P. are installed.

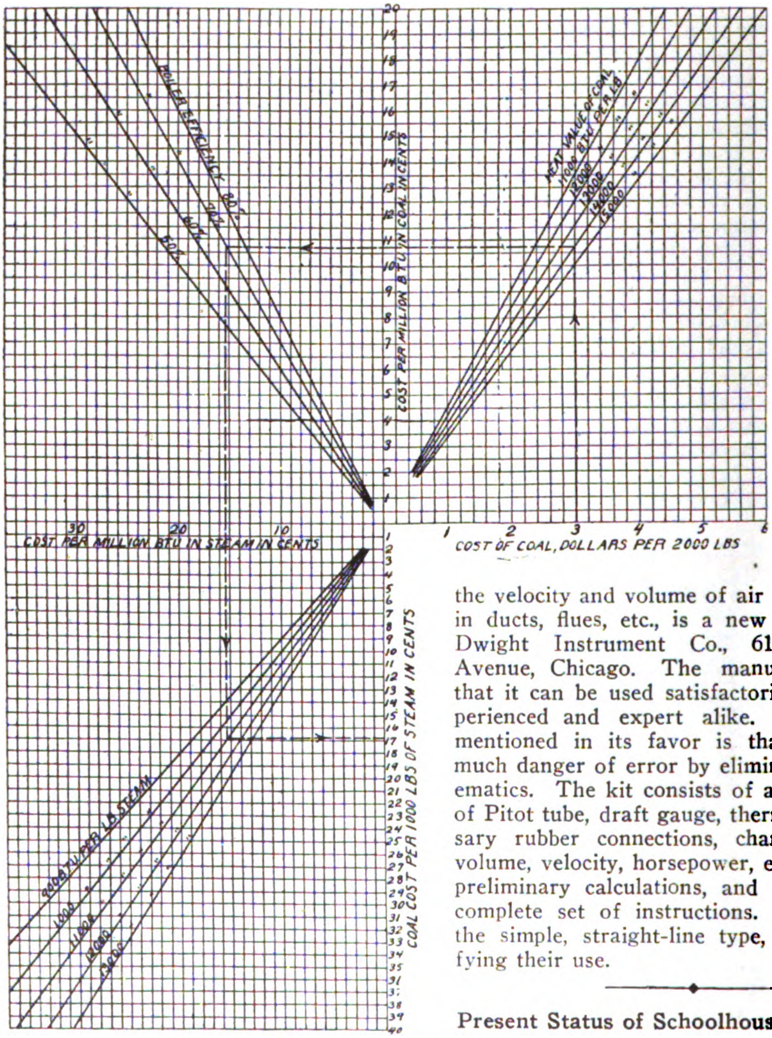
THE COST OF PUMPING WATER is the title of a collecting of graphical charts with accompanying explanatory text issued by the De-Laval Steam Turbine Co., of Trenton, N. J. The object of the publication is to facilitate computation of the overall economy of different types of steam pumping units, having given the cost of fuel, steam pressure, rate of interest, cost of apparatus and other variables. The first chart shows the number of B. T. U. represented by each pound of steam for various combinations of superheat, steam pressure and feed water temperature. The second chart gives the cost of 1,000 lbs. of



HEAT UNITS RECEIVED FROM FUEL PER POUNDS OF STEAM FOR VARIOUS STEAM PRESSURES, SUPERHEATS AND FEED WATER TEMPERATURES.

steam and the cost of a million B. T. U. in the steam from the cost of coal per ton, the heat value of the coal and the boiler efficiency.

The third diagram shows the relation existing between the average cost of steam turbine-driven centrifugal pumping units and the head pumped against. The fourth diagram shows the amount of money to be set aside yearly for sinking fund, to cover depreciation for different terms of life and rates of interest. The fifth diagram is the well known Mollier



COST OF HEAT AND STEAM FOR VARIOUS FUEL COSTS, HEAT VALUES, BOILER EFFICIENCIES AND STEAM CONDITIONS.

velocity of steam in feet per second and the corresponding duty in foot pounds per 1,000 steam chart supplemented by a convenient scale by means of which B. T. U. available per pound between given limits, the resulting lbs. of steam, and the pounds of steam per H. P. hour may be read off directly. The sixth diagram is an alignment chart for determining the resistance of pipes to flow of water. At the end of the publication is a list of representative municipal installations of DeLaval steam turbine-driven centrifugal pumps. Size 6 x 9 in. Pp. 8.

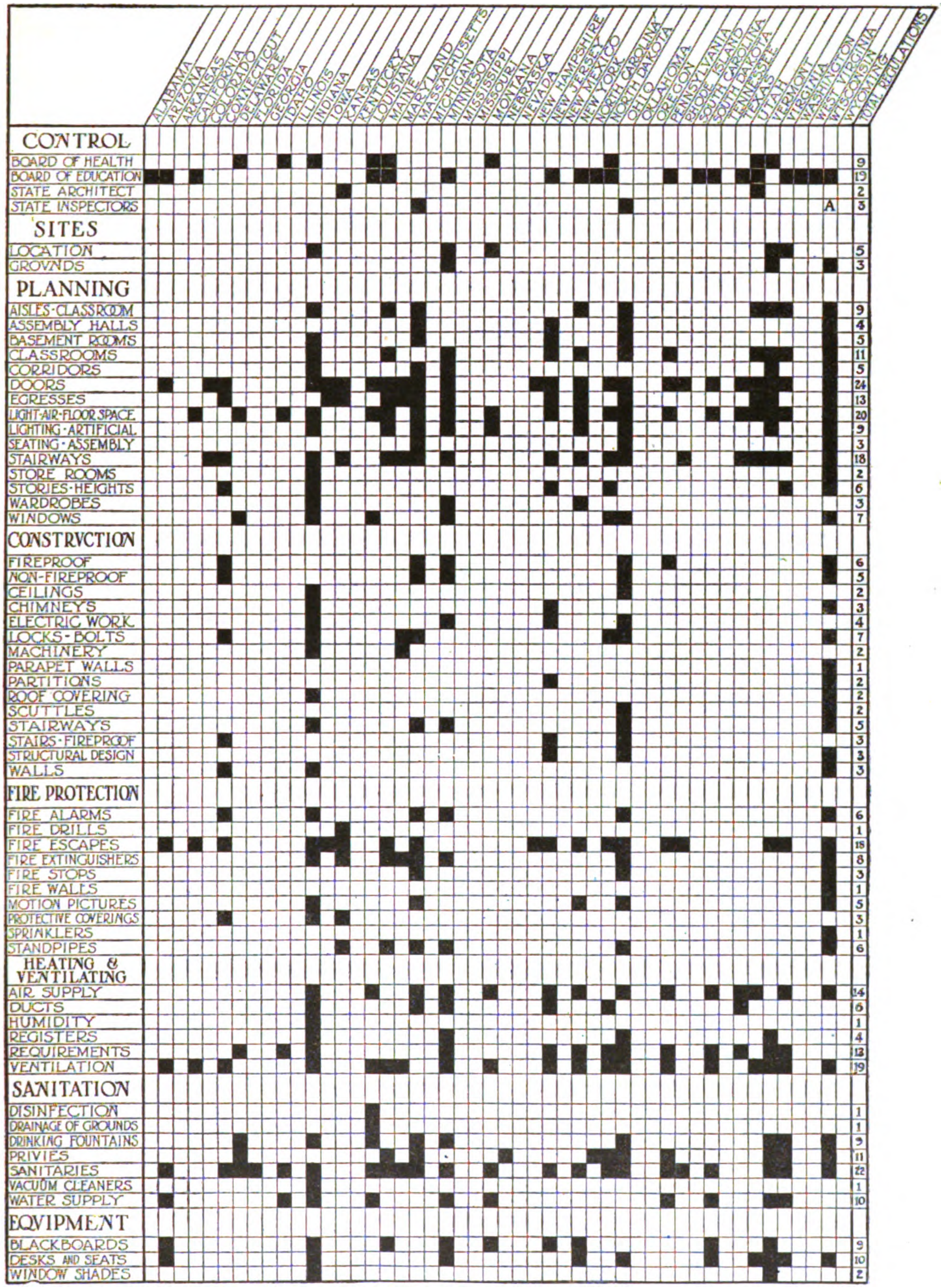
Gilbert Air Measuring Kit, for measuring the velocity and volume of air and other gases in ducts, flues, etc., is a new product of the Dwight Instrument Co., 6100 Greenwood Avenue, Chicago. The manufacturers state that it can be used satisfactorily by the inexperienced and expert alike. Another point mentioned in its favor is that it eliminates much danger of error by eliminating all mathematics. The kit consists of a standard form of Pitot tube, draft gauge, thermometer, necessary rubber connections, charts for finding volume, velocity, horsepower, etc., without any preliminary calculations, and there is also a complete set of instructions. Charts are of the simple, straight-line type, further simplifying their use.

Present Status of Schoolhouse Construction in the United States.

New data on schoolhouse construction in the United States are contained in the accompanying chart, compiled by Frank Irving Cooper, of Boston, and published in Safety Engineering for August. The chart in the general form here presented is similar to the one originally designed by Mr. Cooper and published in The Heating and Ventilating Magazine for April, 1911, covering the regulations in force at that time.

CHART SHOWING STATUS OF REGULATION OF SCHOOLHOUSE CONSTRUCTION IN THE UNITED STATES IN THE YEAR 1915

COMPILED BY FRANK IRVING COOPER, ARCHITECT BOSTON.



A THIS CONTROL IS BY THE WISCONSIN INDUSTRIAL COMMISSION.

■ INDICATES REGULATION IN FORCE.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

CENTRAL HEATING—

Central Heating. Charles L. Hubbard. Compared with small individual heating plants. 2,000 w. Nat. Engr.—Aug., 1915. Serial, 1st part. 20c.

COOLING SYSTEMS—

Getting the Proper Vacuum in Summer. J. Wilmore. Characteristics of cooling systems, requirements and designs. Ills. 4000 w. Elec. Wld.—Aug. 14, 1915. 20c.

GAS RADIATORS—

Efficiency of Gas-Fire Radiators. Editorial on the methods of determining, especially the bolometer described by W. A. Bone, and H. L. Collendar, with H. James Yates. 1600 w. Engng. Aug. 6, 1915. 40c.

HEATING PLANTS—

Heating and Ventilating Large Factories. O. H. Bathgate. Operation of a large industrial plant. Ills. 2200 w. Elec. Jour. —Aug., 1915. 20c.

Panama-Pacific International Exposition.

9—J. H. WILLIAMS & CO.

The highest award for drop-forged tools at the Panama-Pacific International Exposition was awarded to J. H. Williams & Co., of Brooklyn, N. Y.

The exhibit is enclosed on three sides by a fence composed largely of various sizes and styles of chain pipe wrenches against which rest large sample boards bearing the drop-forged products for which the company is so well known. In the immediate center stands a duodecagonal cycloram from the roof of which rises an extended forearm with hand clasping a wrench. Walls composed of sample boards carrying a large variety of special forgings and forged tools revolve constantly. Above these boards are engravings illustrative of the progress made by the forging industry since its inception.

ADVERTISERS' INDEX

THE HEATING AND VENTILATING MAGAZINE

1123 BROADWAY NEW YORK DECEMBER, 1915

Notes on the Use of Heating Coils

WITH EXAMPLES OF PROPER AND IMPROPER DESIGN.

BY T. W. REYNOLDS.

A method of heating the smaller rooms of factories by direct steam radiation is shown in Figs. 1 and 2. If the available space along the outer exposed walls is limited, as sometimes occurs, the radiation is placed overhead in the form of horizontal ceiling pipe coils, although in this location they are somewhat less efficient. Naturally, the most effective radiation is that whose surfaces are exposed to the coldest air currents. This and other reasons favor the installation of wall radiation, although it must be remembered that the advantages thereby secured are slightly offset in the use of ceiling coils in that each pipe is more efficient than when placed in a wall coil. When either arrangement is followed, the coils should be set at a sufficient distance from the wall or ceiling to allow for a free circulation of air around their parts. Overhead radiation should be at least 12 inches below the ceiling.

Ceiling coils are sometimes objectionable to those who sit beneath them, as in factory offices, where the headroom may be limited, due to their radiation which tends to heat the head and upper portions of the body. On the other hand, under some conditions ceiling coils are especially desirable, as when placed under cold roofs and skylights which are directly exposed, with no intervening space above, in order to prevent the downward flow of cold air. Where cranes, belts and machinery in motion are used, these help to maintain the circulation of air around such coils and distribute the heat throughout the room.

Referring to Fig. 1, the full lines indicate the steam pipe and the dotted lines. the return pipe. The return main should be nearly the same size as the supply main to allow for the cubic contents of the pipe being partially taken up by the steam which, in this system, is maintained with but slight drop in pressure up to the lifting trap. All main supply lines slope 1 inch in 20 feet, and all main return lines slope 1 inch in 15 feet, the direction of flow being shown by the arrows. The supply branches from the mains to the coils slope 1 inch in 3 feet. These should not be too rigid and allowance should be made for expansion and contraction of both piping and pipe coils.

An automatic air valve is placed on the return header opposite its outlet. This is the proper point, as the air settles to the lowest end of the coil which is pitched toward the return. In addition, the pressure and flow of steam from the opposite end aids in the relief of the air.

NEED OF GATE VALVES ON PIPE COILS.

A gate valve is installed on each supply and return branch at the coils to prevent the entrance of steam from either direction, should the coil be valved off for repairs or in accordance with weather conditions, when it may be desired to shut off every other coil. Gate valves should be given preference over globe valves as the latter, due to their interior web or diaphragm which forms an integral part

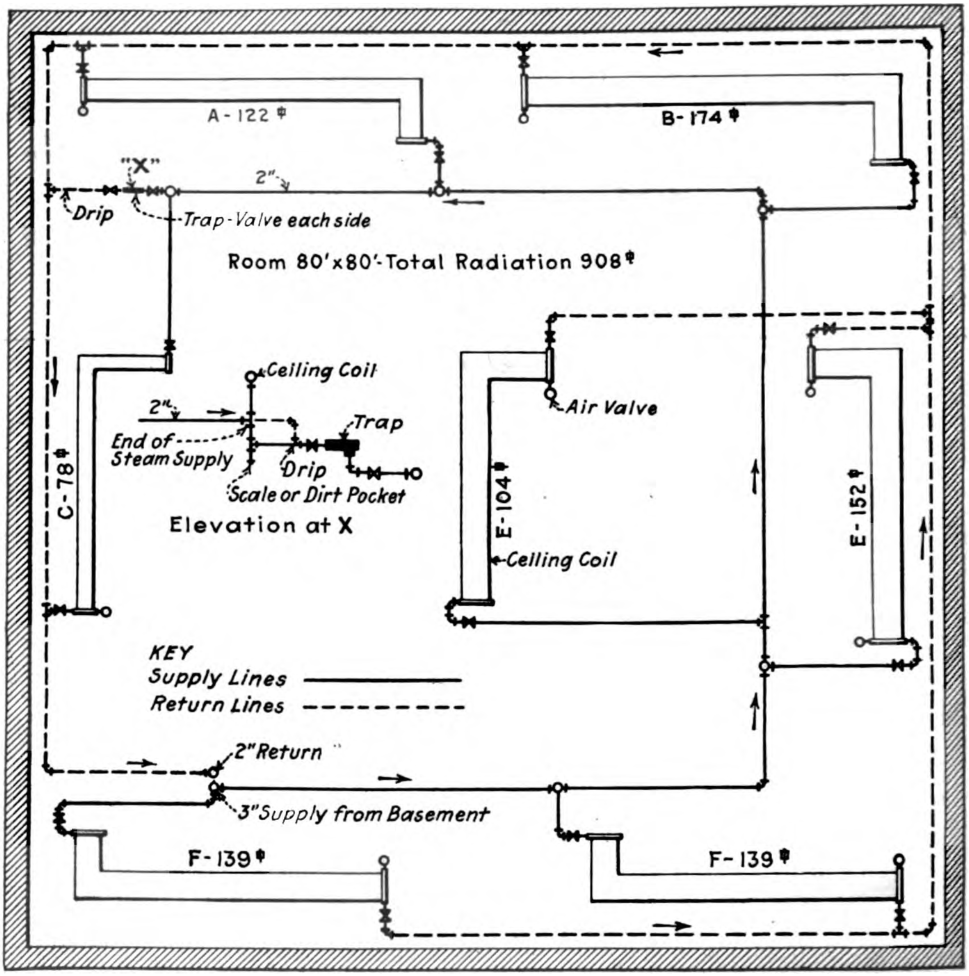


FIG. 1.—FIRST FLOOR PLAN—CORRECT METHOD OF PIPING TO CEILING COILS.

of a globe valve, impede the free drainage of the pipe and retard the condensation until the cross area of the pipe is practically filled. If necessarily used, they should never be set vertically on horizontal pipes, but should be turned through an angle of 90° to lie on their sides. In this position they retain less condensation, but their use is still open to more or less objection, due to water leaking through the packing of the valve bonnets.

Supply branches to coils are connected from the top of the steam main. This prevents condensation from entering the coils. The steam main is continued to supply all coils and with but slight reduction in size to its end just after the last coil supplied, at which point it is dripped to the return through a thermostatic trap

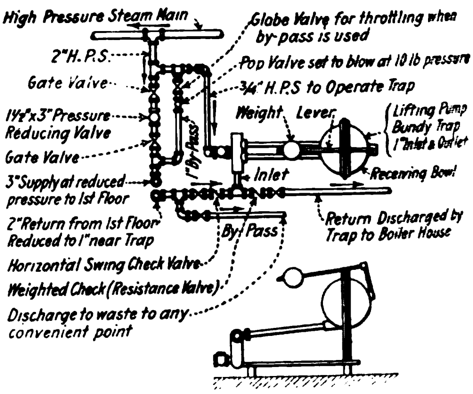


FIG. 2.—PLAN OF LIFTING PUMP TRAP, REDUCING VALVE, ETC., IN BASEMENT.

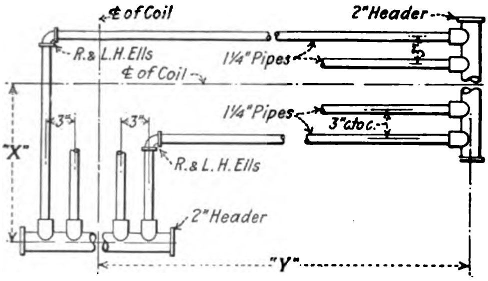


FIG. 3.—DETAIL OF CEILING PIPE COILS.

having a shut-off valve at either side to allow for its repair or occasional adjustment. A scale or dirt pocket, consisting of a capped nipple extended vertically downward, is placed before the trap, as

TABLE FOR USE IN MAKING UP PIPE COILS

Coil	No. Wanted	No. of Pipes	"X"	"Y"	Square Feet Heating Surface
A	1	8	6'-0"	29'-0"	122
B	1	10	8'-0"	32'-0"	174
C	1	6	8'-0"	22'-0"	78
D	1	10	8'-0"	21'-0"	104
E	1	10	8'-0"	27'-0"	152
F	2	10	6'-0"	26'-0"	139
				Total	908

shown in Fig. 1. The portion dotted indicates an advisable method of connecting the trap to the end of the main when the distance from the latter to the last ceiling coil which it supplies is slight. Otherwise the condensation may be lifted by the pressure and velocity of the steam up and into the coil. The dotted portion

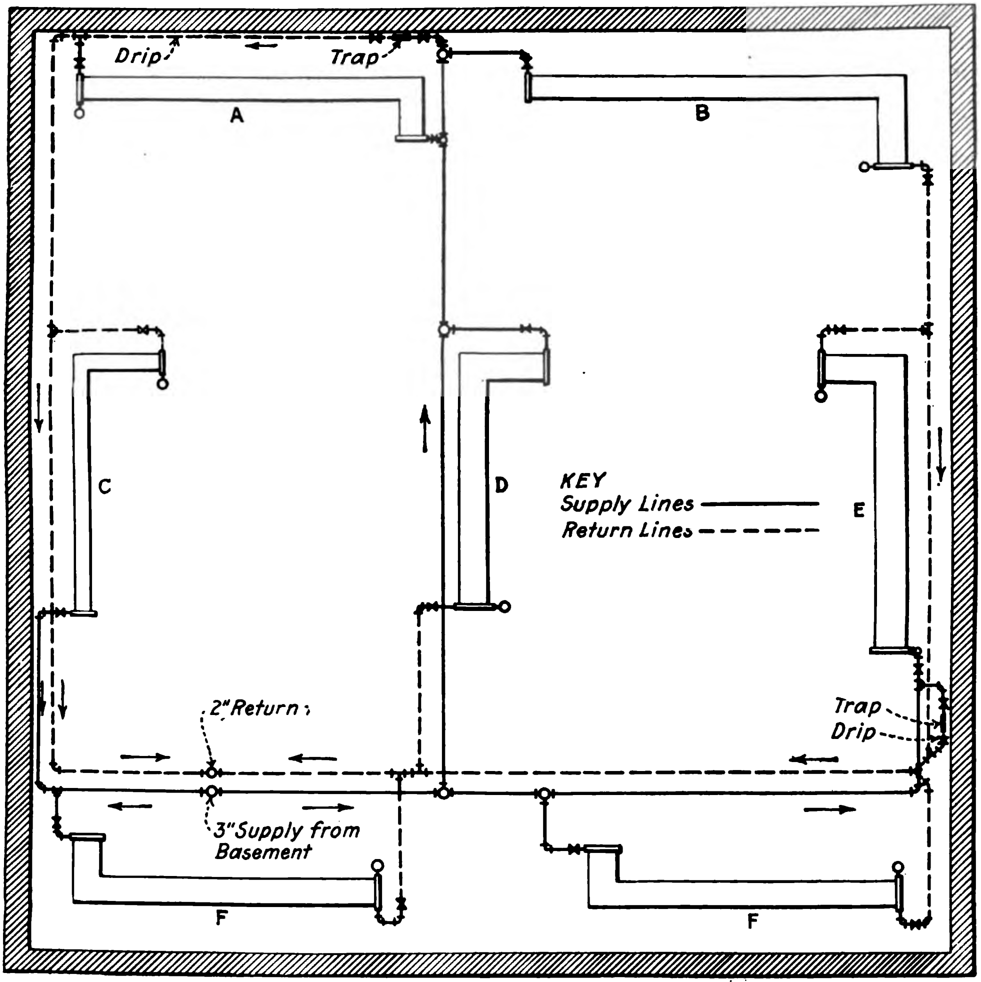


FIG. 4.—FIRST FLOOR PLAN. WRONG METHOD OF PIPING TO CEILING COILS.

should be full size of the steam main and carried 2 ft. beyond the coil before dripping.

STEAM SHOULD BE SUPPLIED THROUGH END OF HEADER ON LONGEST SIDE OF COIL.

Each coil should always be supplied through the end of a header on the longest side of the coil, the return being connected on the same side to the other header. Less short circuiting of the steam through the pipes of the coil is secured than would otherwise be obtained. Furthermore, as each pipe coil pitches downward in the direction of its return end, it follows that the pipe forming the outer and longer side of the coil will be at the lowest point at that end. This, aided by the use of an eccentric fitting or reducing ell connected into the 2 in. return header, allows for the complete drainage of the coil.

WATER HAMMER IN COILS.

Steam rapidly condenses when in contact with the cold water of trapped piping or coils and creates severe concussions as the two bodies of water come together, the resulting vacuum inducing a rapid flow of more steam which slams the condensed steam (water) against elbows, valves, bends, etc., with terrific force or shock. The difficulty may be partially overcome by the use of proper pipe covering which will insure a smaller amount of condensation.

The size of the supply mains should not be reduced too much as the branches are taken off. Friction is much greater in proportion in the smaller sizes of pipes, the ratio of friction surface to volume increasing rapidly. An installation will produce better results if all pipes are one or two sizes large, but very unsatisfactorily, if at all, when they are undersize. Pipe smaller than ¾-in. should not be used either as supply or return piping, for allowance must be made in figuring the required cross area of the pipe, for certain practical conditions, such as inside pipe corrosion, good drainage, pockets, sagging of pipe, mechanical injury, etc. No traps or pockets should be allowed to form where reductions in the size of pipe are made. Eccentric fittings may be used or lines dripped at such points. Pipes should be held firmly in place and prevented from sagging by using substantial hangers.

FIGURING BOILER CAPACITY REQUIRED.

In figuring the necessary boiler capacity required all mains and branches should be counted as radiating surfaces unless thoroughly covered with a good heat insulator. A low pressure steam heating main will give off approximately 2 B. T. U. per square foot per degree of temperature difference between the steam and the surrounding air. In some installations the steam mains are covered, while covering is omitted from the return pipes, as the latter, being at a lower temperature, lose less heat. Furthermore, the return pipes are often installed near the floor (and necessarily so where wall coils are used). In this location their covering is liable to injury.

CONSTRUCTION OF COILS.

A detail of the ceiling coils is shown in Fig. 3. These are constructed with right and left hand ells for the ready removal of pipe lengths, and of the number of pipes located; and are of a length from their longtitudinal centres to the center of the perpendicular spring or expansion piece, as indicated by X and Y in the accompanying table, which also gives the corresponding square feet of heating surface. The supply to the wall coils enters the uppermost header and for this reason the distance X should be limited to the height determined by the accesibility of the supply valve. It should, however, never be less than 8 in., to allow for expansion of the pipes in the coil.

The pipes of the coil are 1¼-in. in size, connecting on 3-in. centers to the two 2-in. headers. The pipes of a ceiling coil are all in the same plane, the resulting increased efficiency allowing the use of coils 8 or 10 pipes wide.

OPERATION OF COILS.

The ceiling coils are supplied by steam reduced from high pressure through the reducing valve located in the basement. As steam is carried at high pressure to each building, it allows the use of smaller pipe from the boiler house or other source up to the entrance of each building, at which points it is reduced as may be required for heating or other purposes. The pressure reducing valve (Fig. 2) is valved either side to allow for repairs, and is by-passed by a line which should always be, in size, one-half the diameter of the inlet to the reducing valve, and pro-

vided with a valve of the globe type, for throttling the high pressure steam by hand should the reducing valve be rendered inoperative. A pop valve, set to blow at 10 lbs. pressure, should be placed on the outlet side of the by-pass to relieve any pressure in excess developed by improper operation of the reducing valve, or by too free a use of the by-pass. As the usual path of the steam is through the reducing valve, the latter is placed in the straight run of the line to avojd any unnecessary turns.

Gauges, one on each side, indicate the two different pressures. These are particularly desirable in connection with the use of the by-pass. Companion flanges or flanged pipe fittings (extra heavy for high pressure steam and standard weight for low pressure having pipes of larger sizes) or unions, where screwed fittings are used, facilitate the removal of the reducing valve for repairs.

The return is reduced at the trap (Fig. 2) to the size of the latter, which is equipped with a by-pass discharging to the atmosphere at any convenient point to a height dependent upon the steam pressure in the heating system at the trap. With this arrangement, the trap may be temporarily removed or valved off for repairs. Necessary unions should be installed for similar reasons. Check and shut-off valves are placed either side of the trap inlet.

In a manufacturing plant where it is desired to measure the condensed steam as a basis of charge for the steam used by different departments, such as drying ovens, glue pots, etc., and for heating, as may be desired by the works accountant, the tilting type of steam trap may be made to serve an additional purpose. Each operation of this trap represents a certain number of pounds of condensation, so that by properly attaching counters to record the operation of the trap, a continuous record of steam consumption for the line to which it is connected may be secured.

EXAMPLE OF IMPROPER DESIGN.

Fig. 4 indicates a method occasionally used for the same type of system as shown in Fig. 1, but the use of this method is invariably followed by poor results in operation, due to short circuiting of the steam through the nearest coil back to and through the return. It has some advantages in that the return and supply lines are shorter in length, consequently there is less condensation to create water hammer, than those shown in Fig. 1. A more economical installation is possible because of smaller and less pipe. Furthermore, the distance below the ceiling is somewhat less, due to the shorter runs.

The return line shown in Fig. 1 continues frm the first coil with a pitch to the end causing it to drop 17 in. in all below the elevation of its starting point. As the latter is also somewhat below the ceiling, the total drop may decrease the available headroom and present a poor appearance along windows or elsewhere. However, the method shown in Fig. 4 is not advisable, particularly for a system in which the steam flows in both the supply and return lines, such as in the one shown. For example, referring to Fig. 4, the steam would flow through its first connection to and through Coil D back to the return and short circuit to the lifting trap, thereby retarding the supply to and the return from all other coils beyond that point. Pressure decreases in accordance with the distance from its source and the friction surface encountered, steam tending to flow through the line of least resistance (usually the shortest distance) to the place of lowest pressure, which in this case exists at the lifting trap. This is particularly noticeable where the pipes are undersize or where in old plants additional radiation, with long horizontal runs, has been added from time to time without an increase in the size of piping. Under these conditions the first radiating surfaces are best, and sometimes the only ones served. In Fig. I, the flow in the supply and return mains are both in the same direction as shown by the arrows.

For example, Coil F is supplied and its branch return connected to the main return, then Coil E is supplied and its branch return connected to the main return in the order given, and so on until the last coil is served. In Fig. 4, the flow in the two mains is in opposite directions. The method shown by this figure would also involve the use of two traps with necessary valves, piping, etc., for

dripping the ends of supply runs. The branch to the coils F and C could be pitched upward in the direction of the flow. Inasmuch as this run is short the condensation could be allowed to drain back against the flow of steam; by slightly increasing the size of the branch the use of another trap could be avoided.

New Radiation Coefficients

BASED ON THE TESTS MADE BY THE HEATING DEPARTMENT OF THE UNIVERSITY OF LONDON.

Based on tests conducted at the offices of Messrs. John Grundy, Ltd., London, new formulae were submitted at the recent meeting of the (British) Institution of Heating and Ventilating Engineers by Walter Jones. These tests were made during January and February, 1914.

After noting that the heat loss coefficients (K) given by different authorities varied somewhat, it was proposed to adopt the following:

TRANSMISSION TABLE.

			K	
Glass	from 1	to 1.09	1	per square foot
Walls (outer)	from 0.14	to 0.37	0.25	per square foot
Walls (inner)	from 0.12	to 0.28	0.17	per square foot
Ceilings, with room above	from 0.17	to 0.35	0.2	per square foot
With roof space above			0.3	per square foot
Floors	from 0.17	to 0.17	0.1	per square foot
Air	from 0.018	to 0.019	0.018	per cubic foot

(Note.—1 B. T. U. will raise 55 cu. ft. of air 1° F., hence 1 B. T. U. ÷ 55 = 0.018 (K) per cubic foot of air.

EMISSION TABLE.

The heat emission from radiators varied from 1.3 to 1.7 B. T. U. per square foot per degree per hour. The emission from plain pipes varied from 1.7 to 2.2. It was proposed to adopt 1.5 B. T. U. as a coefficient.

Window area should include frames and sashes; i.e., wall to wall. Inner wall should be ignored when the room or passage on the other side of it is warmed to approximately the same temperature.

Floors may be ignored when the room below is warmed.

FORMULA NO. 1.

To determine the heat loss, then, from any given building material, the area in square feet (or volume in cubic feet in the case of contents) of the transmitting medium x K = T. For instance, 48 sq. ft. glass x 1 = 48.

As the amount of heat transmitted per unit of surface area depends upon the temperature of the room, the temperature of the outer air and the rate of transmission of the cooling agent, then

$(t_r - t_o)\,K = T$ for difference in temperature, where

t_r = temperature in degrees F. inside of room.

t_o = temperature in degrees F. outside of room.

T = transmission through cooling agent.

K = coefficient (loss in B. T. U.) per square foot of radiator, etc., per degree per hour.

FORMULA NO. 2.

Let H = the B. T. U. emitted per square foot of radiating surface per degree per hour. The area in square feet of heating surface x H = E, where H equals the coefficient (gain in B. T. U.) per square foot of radiating surface per degree per hour and E the emission of heat from the radiating surface per square foot per degree per hour.

For instance, 32 sq. ft. of radiation x 1.5 = 48.

As in the previous case, the amount of heat emitted per unit of radiating surface depends upon the temperature of the room, the temperature of the heating medium and the rate of emission of the radiator, so that

$(t_w - t_r)\,H = E$ for the difference in temperature where

t_w = temperature in degrees F. of heating medium,

t_r = temperature in degrees F. inside of room.

Now T (transmission through radiator) = E (emission from radiator). Therefore $(t_r - t_o) K = (t_w - t_r) H$. Assuming the temperature of the room to be 60° F., the outer air 30° F., the heating medium, water, to be 160° F., and H to be 1.5, then the constant (C) may be obtained by the following formula:

FORMULA NO. 3.

$$\frac{(t_r - t_o)}{(t_w - t_r) H} = C$$

(constant) to cover the losses due to difference in temperature. For instance

$$\frac{(60 - 30)}{(160 - 60) 1.5} = 0.2$$

FORMULA NO. 4.

C (constant) × K = M (multiple) per square foot of glass, etc., to cover all losses. The unit 1 ÷ the multiple (M) Col. 3 = the reciprocal (D) Col. 4 for each medium. For instance:

He emphasized, however, the need of discretion in providing for the fluctuations in temperature of the heating medium, for north and northeast exposures, altitude, the class of building materials used, construction. etc.

The author then applied the formulae mentioned by Mr. Avery to the room in which the tests were made and compared the calculations and formulae with those shown herewith. As a typical illustration, he took the problem: What amount of radiation is required to obtain 60° F. inside when it is 30° F. outside, with water at 160° F. average temperature, in a room of the following dimensions, assuming the heat emission from the radiator (H) to be 1.5 B.T.U.?

	Area in Square Feet
Glass in windows ...	48
Door	21
Walls (outer)	252
Walls (inner) 18 in.	180
Walls (inner) 9 in...	159

C	K	M		Reciprocal Divisor (D)
0.2 × 1		= 0.2	per sq. ft. of glass	5
0.2 × 0.25		= 0.05	per sq. ft. of wall (outer)	20
0.2 × 0.17		= 0.34	per sq. ft. of wall (inner)	30
0.2 × 0.2		= 0.04	per sq. ft. of ceiling	25
0.2 × 0.1		= 0.02	per sq. ft. of floor	50
0.2 × 0.018		= 0.0036	per cu. ft. of air (one change)	280

By the use of these formulae, stated the author, one is enabled to obtain quickly, with less liability to error, by a simple sum in multiplication (or division) the amount of radiating surface for each cooling medium, and the total surface required for warming the interior.

Ceiling	266
Floor	266
Capacity	2,700 cubic feet × 2 [changes of air,

Working this out according to the Rietschel formula, he obtained the following results:

	Area in square feet		K		B.T.U. per degree		C		Required radiation, square feet
Glass	48	×	1.08	=	52	×	0.2	=	10
Door	21	×	0.25	=	5	×	0.2	=	1
Walls (outer)	252	×	0.28	=	70	×	0.2	=	14
Walls (inner) 18 in.	180	×	0.12	=	21	×	0.2	=	4
Walls (inner) 9 in.	159	×	0.18	=	30	×	0.2	=	6
Ceiling	266	×	0.1	=	26	×	0.2	=	5
Floor	266	×	0.05	=	13	×	0.2	=	2
Interrupted heating		+			61	×	0.2	=	12
Aspect northeast wall		+			8	×	0.2	=	2
Air 2,700 × 2 = 5,400		÷	55	=	98	×	0.2	=	20
Total heat losses					384	×	0.2	=	76

In the foregoing table the coefficient (C) is to cover the losses due to differences in temperature as shown in Formula No. 3. The divisor for air, 55, assumes that 1 B.T.U. will raise 55 cu. ft. of air 1° F.

The author also presented four other examples, one of which was based on Mr. Barker's simplified method, giving 72 sq. ft. of radiation, and one by Prof. Carpenter's formula, giving 56 sq. ft. of radiation. He then calculated the radiation by Formula No. 4, given herewith, and obtained the following result:

	Square feet	M	Required radiation, square feet
Glass	48	×0.2	=10
Wall (outer)	252	×0.05	=13
Wall (inner)	339	×0.034	=11
Ceiling	266	×0.04	=11
Floor	266	×0.02	= 5
Air—cu. ft..	2700×2 changes	×0.0036	=19
			Total=69

It was explained, however, that the number of air changes for any room—without any special provision for ventilation—was an unknown quantity, and might vary from one to three changes per hour. The losses from transmission were usually in an inverse ratio to the cubic capacity of the room; hence the smaller the room the more generous should be the radiation surface allowance for heat emission, and the judgment of the engineer was a most important factor. He would need to carefully consider the aspect and exposure of each room, the thickness of the walls, the number of doors, the number and size of ventilators (if any), and, assuming that the other co-efficients were used as constants, some elasticity would be required to estimate what amount of heat emission would balance the transmission losses due to air changes.

SUMMARY.

Comparison of the results by the various authorities and formulas.

	Professor Rietschel.	A. H. Barker.	Professor Carpenter.	W. Jones.
Example Nos.	1	2-3	4-5	6-7
Glass losses	10	10	14	10
Outside walls	14	13	19	13
Inside walls	10	8	13	11
Ceiling	5	9	10	11
Floor	2	5	..	5
Door	1	..	..	..
Cubic capacity—air	20	18	..	19
Interrupted heating	12	9	..	..
Exposure	2	..	..	..
Total radiation, square feet	76	72	56	69

A NEW FORMULA BASED ON EQUIVALENT TEMPERATURES.

As bearing further on the same subject, the author referred to a previous paper of his, presented in 1913, in which he stated that the results obtained by a long series of tests did not agree with the theoretical calculations commonly used at that time, and that the higher the required temperature inside the room, the greater the error between the theoretical calculations and the results obtained by actual tests.

He then announced that Roger Preston, a member of the institution, had hit upon an empirical formula that gave, so far as could be judged, "a nearer approach to accuracy than anything yet published for finding equivalent temperatures." It was as follows:

To obtain equivalent (inside) temperatures, from any other assumed (outside) temperatures, calculated throughout in absolute temperatures (zero being 458.4° F.) which figures must in all cases be added to the Fahrenheit thermometer reading:

$$Tc = (Tr^{12} - To^{12} - Ta^{12})^{1-12}$$

which might be expressed thus:

The 12th power of the *absolute* temperature of room (Tr^{12})

— the 12th power of the *absolute* temperature outside (To^{12})
+ the 12th power of the *absolute* assumed temperature (Ta^{12})
then the 12th root of the result = Equivalent temperature (Tc).

EXAMPLE.

Example: Given the square feet of radiation necessary to obtain 60° F. inside when it is 30° F. outside, what is the calculated temperature when it is zero outside?

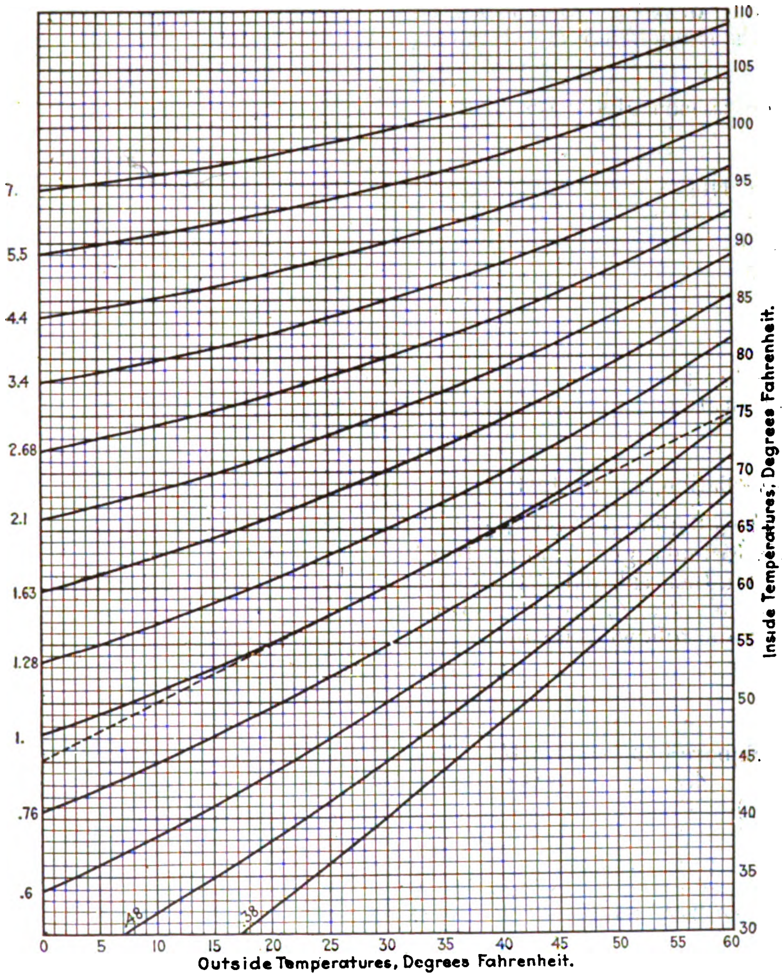


CHART FOR DETERMINING EQUIVALENT INDOOR TEMPERATURES FOR VARIOUS OUTDOOR TEMPERATURES.

	Deg. F.		Absolute Zero Deg F.		Absolute Temperature, Deg. F.
Let Tr = inside temperature	60	+	458.4	=	518.4
Let To = outside temperature	30	+	458.4	=	488.4
Let Ta = outside assumed temperature	0	+	458.4	=	458.4
Then $(518.4^{12} - 488.4^{12} + 458.4^{12})$				=	505.5

And 505.5—458.4 = 47.1° F., as shown in Table 1, over zero outside temperature.

TABLE A.—EQUIVALENT TEMPERATURES CALCULATED FROM THE PRESTON FORMULA.

(30° F. outside to 60° F. inside is taken as unity, or 1. The equivalent inside temperatures are shown from 40° to 100° F.)

Outside Temperatures, Deg. F.												
0	5	10	15	20	25	30	35	40	45	50	55	60
Equivalent Inside Temperatures, Deg. F.												
95	95	96	97	98	99	100	101	102	104	105	107	109
89	90	91	92	93	94	95	96	98	99	101	103	105
83	84	85	86	87	89	90	91	93	95	97	98	101
78	79	80	81	82	83	85	87	88	90	92	94	97
72	73	74	75	77	78	80	82	84	86	88	90	93
66	67	68	70	71	73	75	77	79	81	84	86	89
60	61	63	64	66	68	70	72	74	77	80	82	85
54	55	57	59	61	63	65	67	70	73	76	79	82
47	49	51	53	55	57	60	63	65	68	71	75	78
40	42	44	47	49	52	55	58	61	64	67	71	75
33	36	38	41	44	47	50	53	57	60	64	68	72
		32	35	38	41	45	49	52	56	60	64	68
		24	28	32	36	40	44	47	52	57	61	65

In the above table the equivalent temperatures obtained, say, with 69 sq. ft. of radiation are found on the horizontal line, viz., 47° when 0°, 55° when 20°, 65° when 40° and 78° when 60° outside.

Assuming that some other temperature is required in the same room, refer to the chart, and use the multipliers shown at the left, thus 69 ft. × 0.76 to get 40° when 0°, or 69 ft. × 3.4 to get 90° when 45° outside.

In the foregoing table fractions up to 0.5 being of small value, are ignored and those over 0.5 are counted as 1.

It was suggested that the following be accepted as equivalent inside temperatures for the outside temperatures given below:

When outside temperatures (A) are—
20 22 24 26 28 30 32 34 36 38 40
Calculated inside temperatures (H)—
55 56 57 58 59 60 61 62 63 64 65

A Large Combination Steam and Forced Hot Water Heating Plant

NEW YORK STATE REFORMATORY FOR WOMEN, BEDFORD HILLS, N. Y.

Supplementing the description, published last month, of the central hot water heating plant of the New York State Agricultural School, at Farmingdale, L. I., the accompanying article is presented to further illustrate the practice of the State Architect's office in this class of work.

The present description is that of the central heating plant for a reform school for women, located at Bedford Hills, N. Y., known as the New York State Reformatory for Women, the heating plant for which was designed under the direction of Lewis F. Pilcher, State architect, and G. B. Nichols, chief engineer of the Department of Architecture.

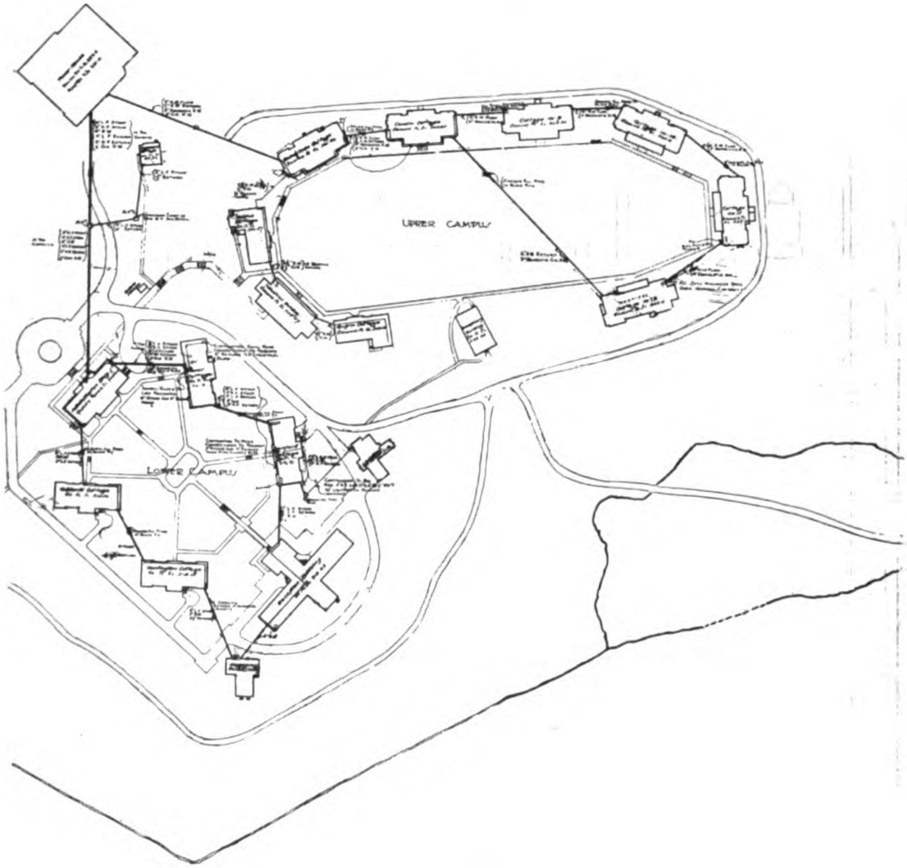
This institution consists of two groups of buildings, eight located on the lower campus and certain buildings located on the upper campus. The latter group was increased by four new buildings, known as Cottages 9, 10, 11 and 12, all of which, except the new buildings, were heated from the original power house located at the site of the new power house. The original equipment consisted of a direct-current lighting plant, together with return tubular boilers. The plant, together with the underground heating mains, had long served their usefulness, and were insufficient to take care of the increase in buildings.

It, therefore, was proposed to build a

new power house, using such portions of the present power house as was possible and to install new underground heating mains to the various buildings. As the present buildings were all piped for direct and indirect steam gravity return, it was decided to leave all of the lower campus and the buildings in the upper campus, except the new buildings, piped in the same manner, simply installing new ing these heating mains, which are described as follows:

DESCRIPTION OF HEATING MAINS.

From the power house one 10-in. low pressure steam main is carried to the lower campus, with branch to certain of the upper campus buildings for low pressure heating, together with one 3-in. high pressure steam main for laundry purposes.



BLOCK PLAN OF BEDFORD HILLS REFORMATORY, SHOWING LOCATION OF NEW POWER HOUSE, AND UNDERGROUND SERVICE AND HEATING LINES.

underground steam mains to these various buildings.

In Cottages 9, 10, 11 and 12, it was proposed, on account of their arrangement, to install a forced hot water, one-pipe main, heating system, with two-pipe gravity system within the buildings.

On account of the controversy between advocates of the hot water and steam systems, it was decided to carefully meter each heating main leaving the power house, the accompanying block plan show-

One 4-in. domestic hot water and one 2-in. circulating hot water main.

One 4-in. low pressure and one 2-in. high pressure steam return.

This group of mains was installed from the power house to the Administration Building in two split tile conduits, at which point the mains divided, passing through the various buildings in the group and connecting to the present steam mains in the basement of each building.

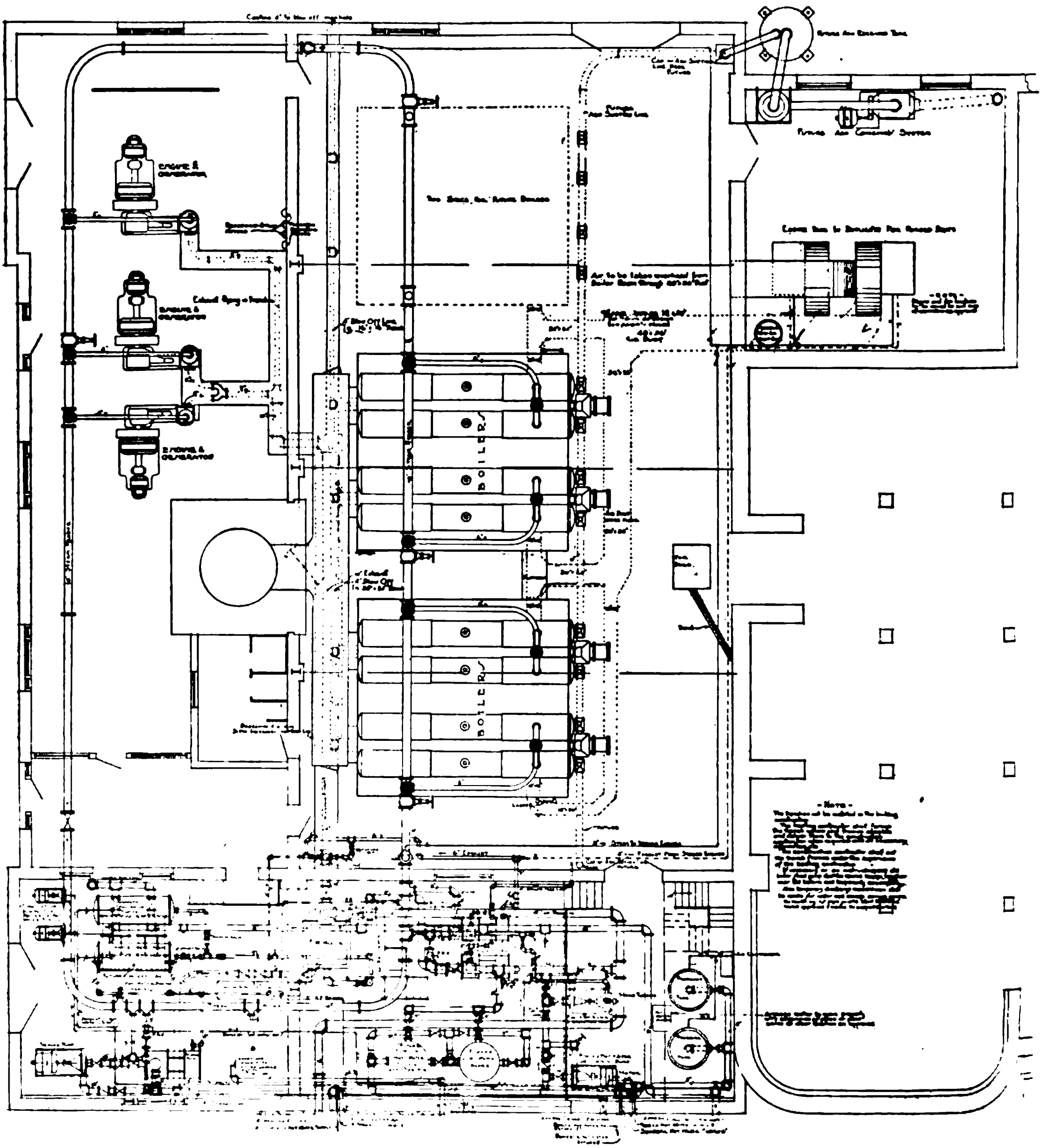
Originally the laundry, located in the

lower campus, was provided with a separate boiler for high pressure steam, which, under the new arrangement, was abandoned, as it is proposed to heat the building and furnish live steam and hot water from the new power house.

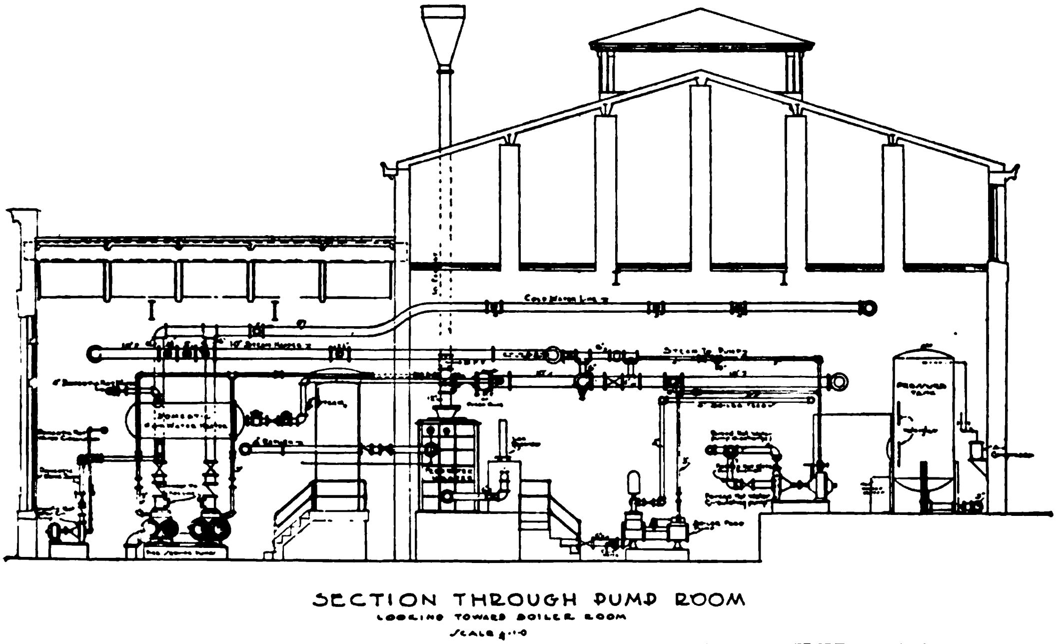
Leaving the power house there was also installed to the upper campus one 7-in. flow hot water heating main with 7-in. return main, together with a 4-in. domestic hot water main with 2-in. circulating main, all run in a split tile conduit to Robertson Cottage and thence to Cowdin Cottage, where the mains divided, forming a loop through Cottages 9, 10, 11 and 12.

The original buildings on the upper campus were left connected by the present underground steam mains at manhole No. 2 near engineer's cottage.

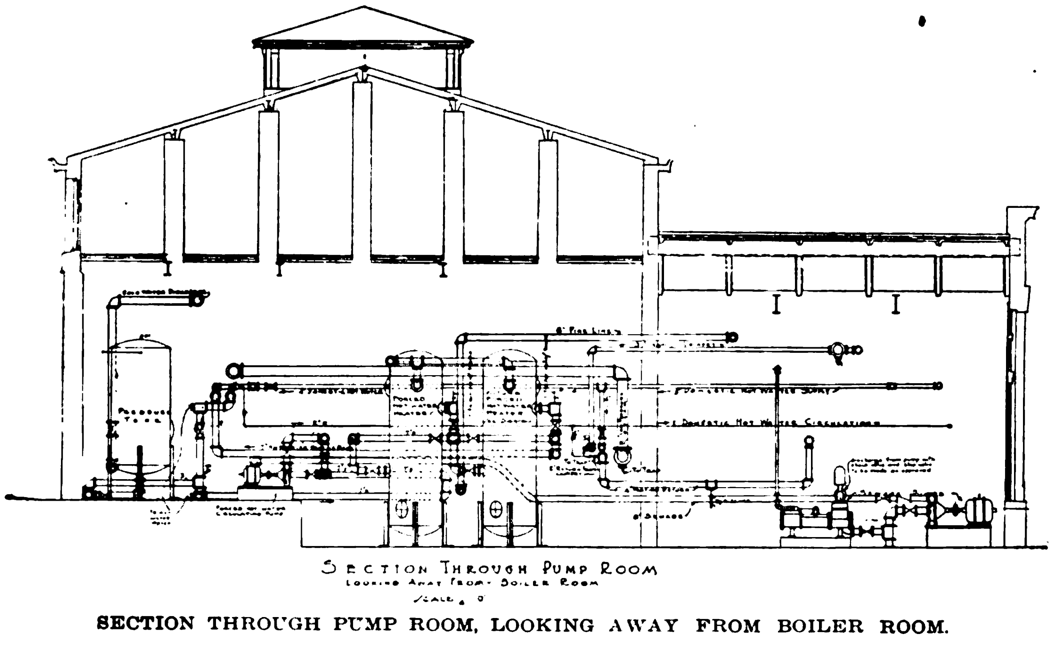
On account of the new plant being built at the site of the old plant, consid-



FIRST FLOOR PLAN OF POWER HOUSE.



SECTION THROUGH PUMP ROOM, LOOKING TOWARDS BOILER ROOM.



SECTION THROUGH PUMP ROOM, LOOKING AWAY FROM BOILER ROOM.

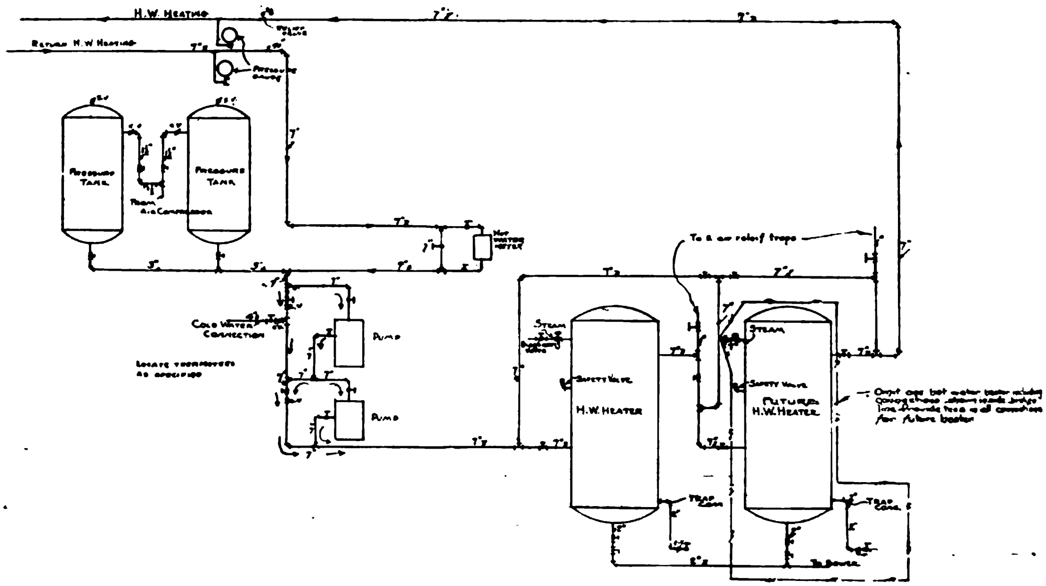


DIAGRAM OF CONNECTIONS FOR FORCED HOT WATER HEATING SYSTEM.

erable difficulty was encountered in keeping the original system in operation while the new building was being constructed directly around the old apparatus, especially as a great deal of this work was carried out during the winter time. By careful forethought, however, this has been accomplished.

The total equivalent direct radiation for the institution is as follows:

Original buildings to be supplied by steam, approximately 35,000 sq. ft. of equivalent direct radiation.

New buildings to be supplied by hot water, approximately 12,500 sq. ft. of equivalent direct radiation.

The design, however, is to provide for approximately 30,000 sq. ft. of radiation connected to the forced hot water heating system and approximately 40,000 sq. ft. of direct radiation for steam service.

ARRANGEMENT OF BOILER HOUSE.

The boiler house consists of a brick building with asbestos roof and so designed that coal can be delivered directly from auto truck to the coal pocket. All

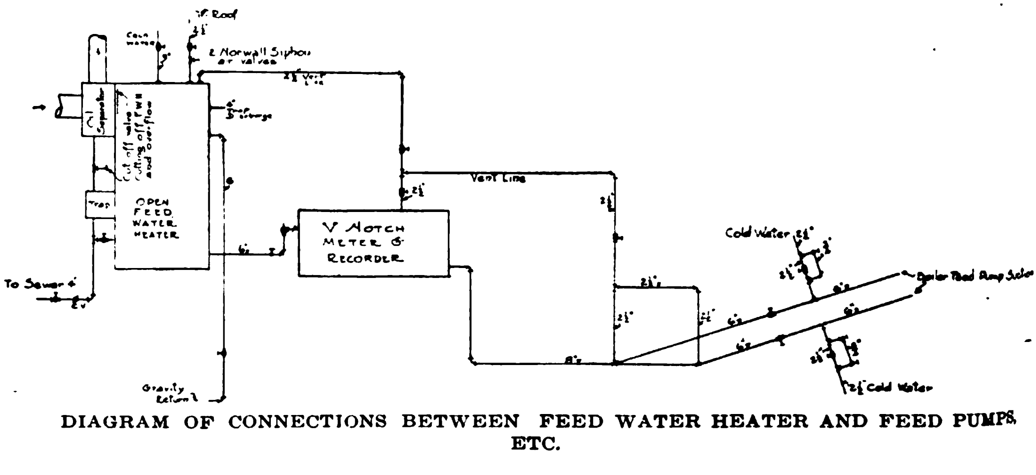


DIAGRAM OF CONNECTIONS BETWEEN FEED WATER HEATER AND FEED PUMPS ETC.

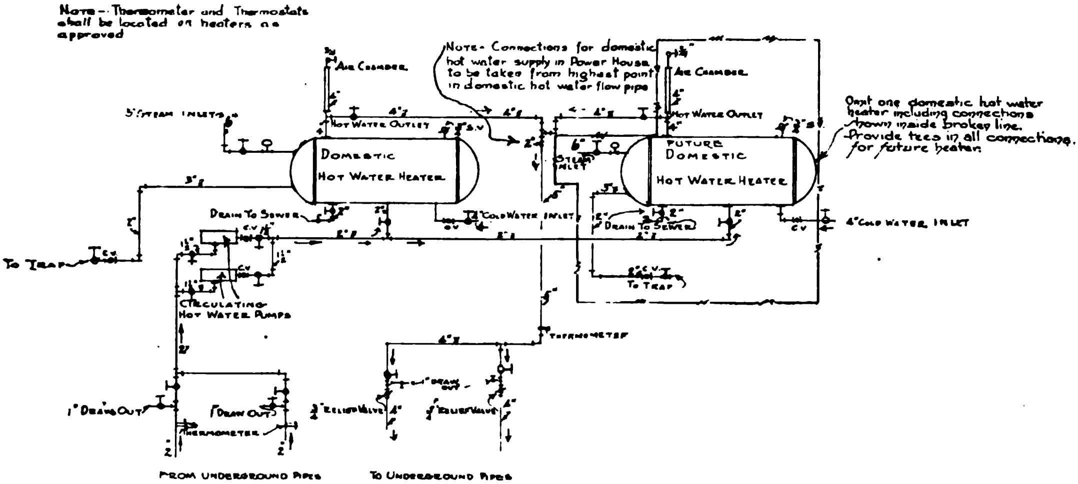
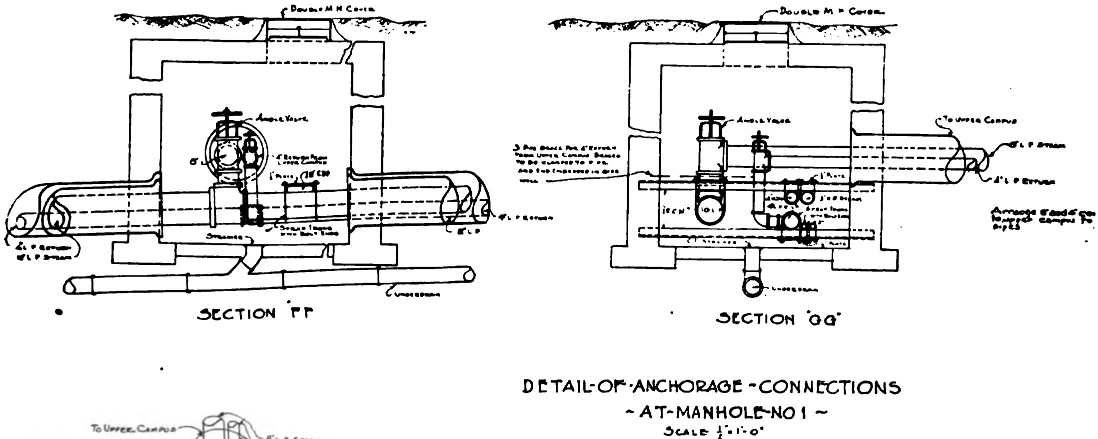
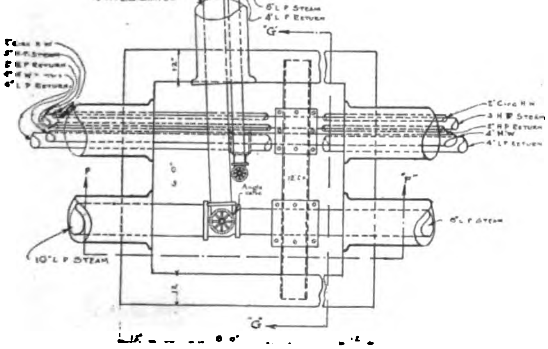


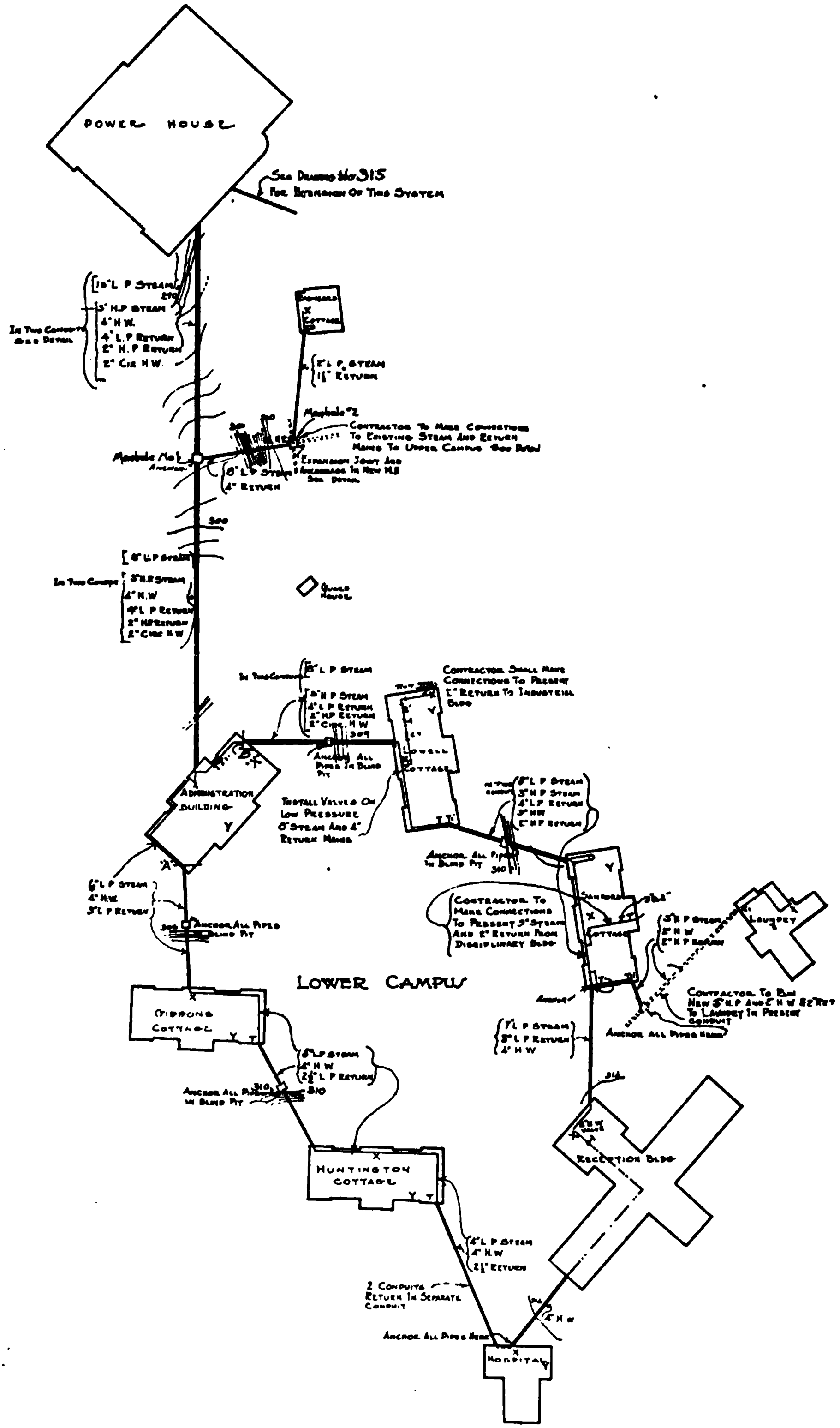
DIAGRAM OF DOMESTIC HOT WATER HEATER CONNECTIONS.



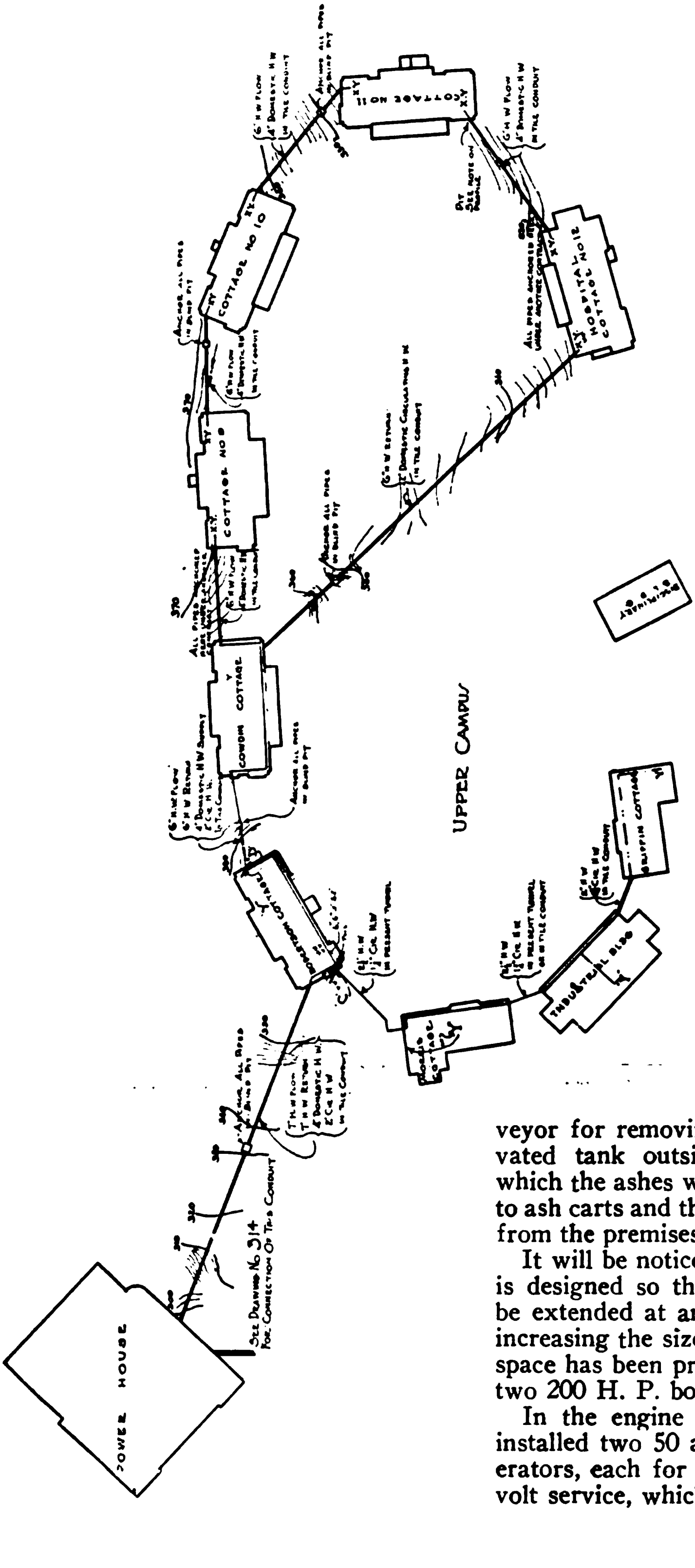


PLAN

DETAIL OF ANCHORAGE CONNECTIONS AT MANHOLE NO. 1.



BLOCK PLAN OF UNDERGROUND CONDUIT LINES FOR THE LOWER CAMPUS.



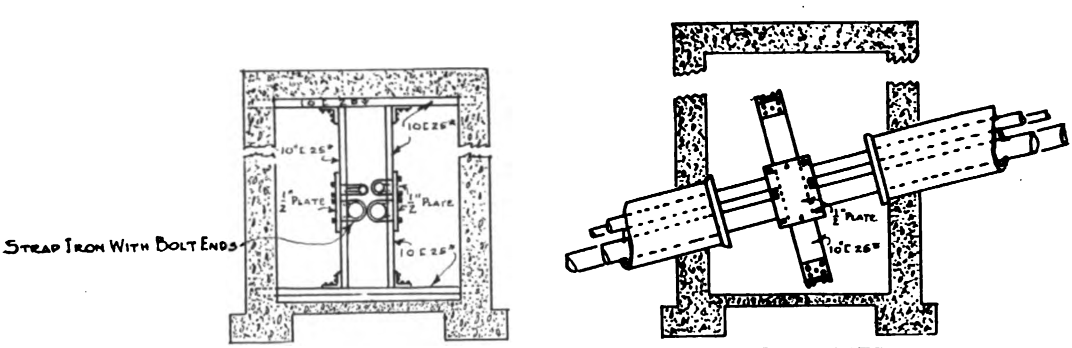
BLOCK PLAN OF LINES FOR UPPER CAMPUS.

of the equipment is now installed and is operating satisfactorily, and it is hoped that a considerable amount of data will be obtained during the coming winter in reference to steam and hot water heating, so as to make a comparison of the two systems under the same conditions, as most of the buildings are of the same general character of construction.

The boiler plant consists of four 200 H. P. McNaull non-sectional, water-tube boilers, with red faced brick settings. The top of the boilers has been leveled off smooth with a filling of cinders, over which there has been placed a layer of concrete, making an absolutely smooth surface on the top of the boilers. All of the boilers are furnished with Jones under-feed stokers and the plant is now burning bituminous coal. It is proposed in the future to install a suction ash conveyor for removing the ashes to an elevated tank outside the building from which the ashes will be delivered directly to ash carts and the same will be removed from the premises.

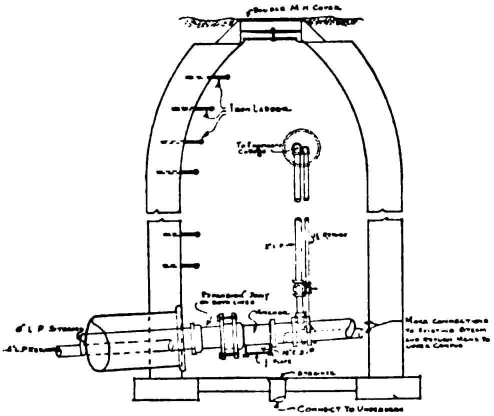
It will be noticed that the boiler house is designed so that the boiler room can be extended at any future date, thereby increasing the size of the plant, although space has been provided for a battery of two 200 H. P. boilers.

In the engine room there have been installed two 50 and one 75 K. W. generators, each for 3-phase, 60 cycle, 2300 volt service, which generators are of the

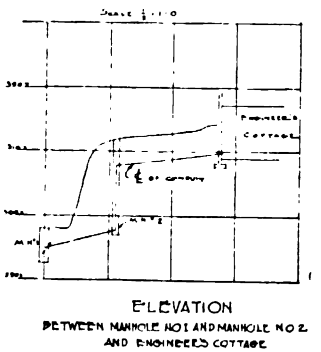


TYPICAL METHOD OF ANCHORING PIPES IN BLIND PITS.

Ft. Wayne Electric Company's make, together with the switchboard. Each generator is direct connected to a high speed engine of the Ball Engine Company's make, together with a direct connected exciter. There has also been installed in the engine room one constant current transformer for supplying a series incandescent ground lighting system, which lights are located throughout the institution.



SECTION THROUGH MANHOLE NO. 2.



ELEVATION BETWEEN MANHOLE NO. 1 AND MANHOLE NO. 2 AND ENGINEER'S COTTAGE.

It will be noticed that there has been installed a 10-in. steam header circling the entire power house, making it possible to repair any portion of same and still keep service in operation.

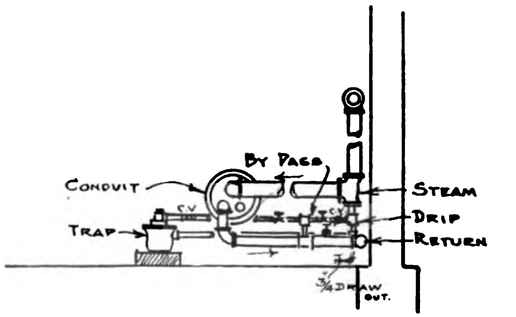
The chimney has been installed directly in the center of the power house, and is 7 ft. in diameter by 150 ft. high.

EQUIPMENT OF PUMP ROOM.

In the pump room there has been installed the following apparatus:

Two forced hot water heaters, each heater being 54 in. in diameter by 14 ft. high and containing 150 2-in. tubes, each tube being 7 ft. long, spaced on 3 ¼-in. centers, making a total of 555 sq. ft. of heating surface for each heater. These heaters are to be used in connection with heating the water for the forced hot water heating system and so arranged that either heater can be supplied with low pressure steam.

In connection with the forced hot water heating system, there have been installed two forced hot water circulating pumps, one pump being motor-driven and the other steam turbine driven, the use of same depending on the electric load at



TYPICAL DETAIL OF TRAP CONNECTIONS FOR NEW LOW PRESSURE STEAM MAINS AT POINTS OF LEAVING BUILDINGS.

the time of operation. The pumps are connected so as to operate individually or in series, depending on the demands for heating service. The pumps were furnished by the Gould Manufacturing Company.

In connection with the forced hot water heating, there have been installed two expansion tanks, each tank being 5 ft. in diameter by 10 ft. high, the air cushion on the top of same being maintained by one Westinghouse air compressor mounted on the wall near tanks.

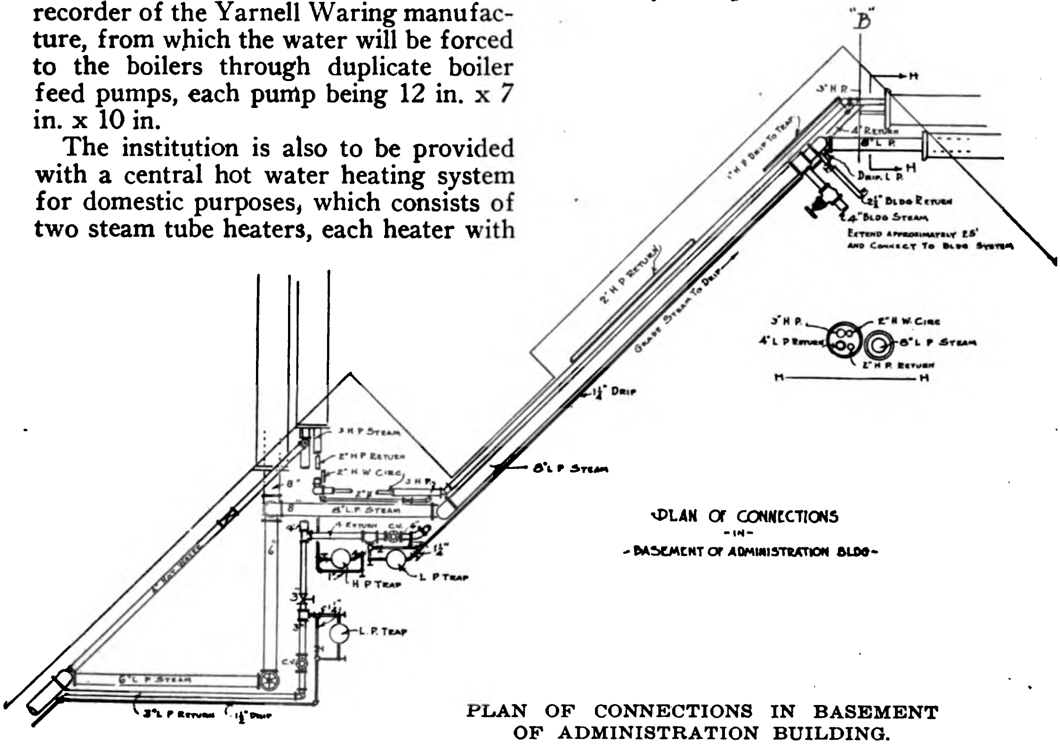
All of the returns from the heaters and buildings will be delivered to an open feed water heater of the Webster type, which will deliver the water to a V-Notch recorder of the Yarnell Waring manufacture, from which the water will be forced to the boilers through duplicate boiler feed pumps, each pump being 12 in. x 7 in. x 10 in.

The institution is also to be provided with a central hot water heating system for domestic purposes, which consists of two steam tube heaters, each heater with a capacity of heating 4,000 gals. of water per hour.

For maintaining circulation there have been installed two centrifugal pumps, each capable of discharging 40 gals. of water per minute against a head of 10 lbs. per sq. in. and direct connected to a one H. P. electric motor.

There has also been installed in the pump room two water pumps for pumping water from a large open well located near the power house directly to an overhead steel tower tank located at the highest point of the institution for supplying the water for the buildings.

Located a half a mile from the buildings already mentioned is a separate group of four buildings similar to the four new buildings having just been built on the upper campus for cases requiring isolation. This group of buildings is heated by a separate forced hot water heating plant located in the basement of one of the main buildings and it is believed that this also will furnish data regarding central heating as compared with buildings heated by a local plant.



PLAN OF CONNECTIONS IN BASEMENT OF ADMINISTRATION BUILDING.

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An ADDRESS that has a direct bearing on the plans now under way to provide additional opportunities for the education of the heating and ventilating engineer was delivered recently before the Cleveland Engineering Society by Professor John R. Allen. Coming from a past president of the heating engineers' society, his remarks are quite timely. One of the interesting points brought out was that of the graduates in mechanical engineering at the University of Michigan who have been out ten years or more, 90 per cent. are still in engineering; 34 per cent. are presidents, vice-presidents, general managers, or general superintendents of manufacturing corporations; 39 per cent. are superintendents, chief engineers or sales managers of manufacturing corporations; 7 per cent. are constructing engineers, professors, patent attorneys and in special lines; while 20 per cent. are salesmen, in minor positions or in other lines. In other words, the statistics show that almost 80 per cent. make good and reach positions of responsibility, and the speaker well asks, "What community of untrained men can show such a percentage of success?"

Another point emphasized in the address was the criticism that the American engineer is apt to be superficial. In this connection, we believe the following remarks on this topic, made in the course of the discussion of Prof. Allen's address, fairly express the situation and will be a reassurance to many who have, perhaps, envied the thoroughness of the best type of European engineer:

"Because I was raised and educated abroad," said this engineer, "I wish to thank the speaker for his flattering remarks about the thoroughness of the European engineer. However, I think that, on the whole, there is not a great deal of difference, except possibly in the training in mathematics, the European engineer being usually a better mathematician than his American brother. Otherwise, I should be inclined to favor the American methods. * * * Where the European engineer is usually handicapped is in his ability as a business man. His mind is inclined to travel in a narrow groove of technicalities and he often lacks the broad and cheerful outlook on life common to the natives of this country. The reason for this difference, I find, is in the American interest in outdoor sports. Having spent a great deal of his time on the football field or on the tennis court, the young American becomes a mixer, learns to know how the other fellow thinks and feels, and gets the knack of rubbing shoulders with the world at large without getting an elbow in his ribs.

"The European engineer, on the contrary, is usually an indoor man, trained to become a professor in due season, and taught to keep his nose to the grindstone."

THE CONSULTING ENGINEER

The Consulting Engineer" is prepared to reply, in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

CONDUCTED BY IRA N. EVANS, C. E.

54—Simple Remedy for Noisy Heating System.

QUESTION: I have a single pipe steam heating system connected as shown in the sketch with the full lines. The job works all right on about 3 lbs. pressure at the reducing valve, but the radiators hang up with water and air, making a noise when the pressure is raised above the point named.

We are, of course, aware that the horizontal pipe connections between the risers and radiators are too small and too long. Can you suggest any cheap method of assisting the circulation? We thought of running a system of air lines, with connections, to each air valve and using steam ejectors to exhaust the air from the radiators.

The returns now connect a pump governor and are then pumped back to the boiler. Live steam only is used for heating.

ANSWER: Connecting to the air valves with an air line will not help matters, as the reason the radiators do not work now is due to the lower pressure in the radiator than in the riser, causing the water to make a noise in the radiator. The following is suggested: Put on new air valves of the Jenkins type, with drip. Connect a ⅜-in. pipe to the plug on the return end of each radiator, with a 2-in. or 1½-in. outlet and 1-in. on the run, or a 1-in.x1-in.x2-in. tee connecting one outlet to the air valve and the other to the ⅜-in. return, with a small brass strainer in the tee.

Bring the ⅜-in. return to the riser separate with a ⅜-in. check on a drop leg at the point of the supply risers.

Arrange all floors the same and run a new ¾-in. line to the basement, all as shown in sketch, the dotted lines showing the new work. The new line runs alongside each supply riser.

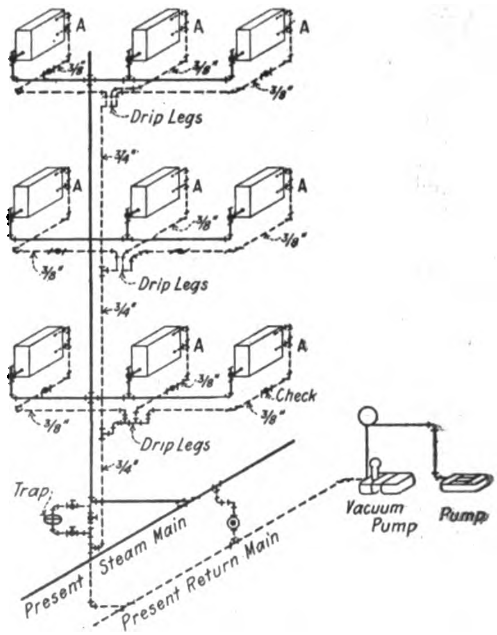
Where the regular drip occurs at the base of each riser, cut in a Dunham or Heintz expansion trap, with by-pass. Carry a new ¾-in. line to a point below the trap and by-pass and connect it in the same drip line, all as shown.

Where drips are necessary on the first floor or basement, these connections should be made to the return through separate traps into present existing return line.

On the end of the present return line place a vacuum pump of the Marsh type and pump air and water into a small overhead air tank. The tank can then be drained to present pump governor and the water passed to the boiler in the same manner as at present.

All dotted lines represent new work and full lines old. Only one riser is shown, but as many as desired may be treated in this manner.

This will enable the job to be operated



SKETCH OF SIMPLE REMEDY FOR NOISY HEATING SYSTEM.

with a vacuum on the return and the air and water can be removed.

When any radiator tends to hang up the water will accumulate in the 3/8-in. returns, forming a solid column which will produce its own vacuum at each riser.

In case there is no water present in the return line the radiator will be operating properly.

The additional connection from the air valve to the return line is not absolutely necessary, but the vacuum on the return will remove any air and prevent any disagreeable drip or leak.

The principle on which each line works is that of the steam loop. The radiator forms the cooling surface at the top of the line and the 3/4-in. riser, with its column of water, balances the difference in pressure between the riser and radiator with something to spare.

This only requires one trap for each riser, instead of one for each radiator. There should be, however, 20 ft. between the lowest radiator and the point of connection to the return drip.

The present basement return line can be used without change and there are practically no horizontal runs except the runouts from the 3/4-in. riser to the individual radiators.

This makes a cheap and efficient method of making a badly piped single pipe system work.

55—Meeeting Indoor Humidity Requirements.

QUESTION: The statement has frequently been made that where air conditioning is employed, the temperature of the air supply may be reduced thereby, lessening the cost of heating. Is this true?

ANSWER: It is not. On account of the evaporation of the water to condition the entering air the expense is considerably increased, even when the temperature of the room is lowered.

We will assume for the discussion 1,000 cu. ft. of air, entering at 0°, at 32° and 25% relative humidity and raised to 65° and 70°. with 45% to 50% relative humidity, and calculate the B.T.U. required for the moisture and dry air.

Below 32° there is practically no moisture in the air, or very little, due to the fact that is below freezing.

The following shows the initial and terminal requirements.

Th table indicates that in all heating weather practically 3 grains of moisture per cu. ft. will have to be added, so this figure will be used in the calculations.

Temperature Outside Air Deg. F.	Relative Humidity, Per Cent.	Grains Moisture per cu. ft.		Grains Moisture per cu. ft. Inside Air.	Grains Moisture To be added, per cu. ft.
0	25	0.2	70° F. 40%	3.25	3.05
30	20	0.4	70° F. 50%	4.0	3.6
40	40	1.0	70° F. 40%	4	3.0

In practice the heat for the room to provide for leakage and radiation may require the air supply to be raised to 120° or some other figure, but this will not affect the final result as when this heat is dissipated to the outside through the walls of the rooms the normal temperature of 65° or 70° obtains and the proper degree of humidity.

The heat required to raise the temperature of the water vapor after the latent heat of evaporation is provided is very little or less than 0.6 of a B.T.U. per pound per degree raise in temperature.

The specific heat of air is 0.2375 and we will assume a weight of 0.075 lbs. per cubic foot of air at approximately 70° F. The heat required to raise the dry air from 0° to 70° F. for 1,000 cu. ft. will be 1,000x 0.075x0.2375x70 = 1,247 B.T.U.

The heat required to raise the vapor of the incoming air to 70° will be as follows: Assuming an average of 0.2 grains per cubic foot, and a specific heat of 0.47 and 7,000 grains to the pound.

$$\frac{0.2\text{x}1{,}000}{7{,}000}\times 0.47\times 70 = 9.4 \text{ B.T.U.}$$

The heat required for the vapor of the incoming air is practically negligible in amount. The heat required to vaporize 3 grains of moisture per cubic foot will be as follows: The latent heat of evaporization at 70° F. is 1,052 B.T.U. per pound. Then

$$\frac{1{,}000\text{x}3 \text{ gr.}}{7{,}000}\times 1{,}052 = 451 \text{ B.T.U. per } 1{,}000 \text{ cu. ft.}$$

or about one-third of the amount necessary to raise the dry air to 70° from 0°.

Suppose the air enters at 65° instead of 70°, with air conditioning as against 70° without. The air would require $\frac{13}{14}\times$ 1,247, or 1,158 B.T.U. 1,158 B.T.U. + 451 B.T.U. = 1,609 B.T.U., as against 1,247, or approximately 30% more heat—than if the air was simply raised to 70° without conditioning.

The actual amount of water required in a building requiring 120,000 cu. ft. of air per hour would be

$$\frac{3{,}000}{7{,}000} \times 20 \times 60 = 516 \text{ lbs. steam per hour,}$$

or 15 boiler horse-power at 34.5 lbs. Almost 8¼ cu. ft. per hour or 62 gal. per hour during freezing weather.

The above figures show that conditioning air is costly, not that the expense may not be warranted.

The horse-power to raise the air from 0° to 70° F. would be $\frac{1{,}247 \times 60 \times 20 \text{ M}}{33{,}000} = 45$ boiler H.P.

LEGAL DECISIONS

When Meter Rate for Steam Heat Is Preferable to Flat Rate.

In an application by an electric company to withdraw flat rates for steam heating service at DeKalb, Ill., it appeared that the steam heating service there is operated in conjunction with the electric generating plant, thereby allowing of the utilization of the exhaust steam from the prime movers. This steam is carried through insulated underground pipes into the consumers' premises, and condensed in the radiators. The measure of the cost of service has been made in the past in two ways: (1) on the amount of radiation installed, and (2) on the amount of steam condensed in the consumers' premises as measured by the water of condensation. The object of the petition was to eliminate the flat rate charge from the schedule, and to place all consumers on the meter basis. The application was granted, it appearing that the meter rate was more just to both the consumer and the utility than the flat rate, which leads to excessive use and waste of steam.—*In re* DeKalb-Syracuse Electric Co.

Breach of Warranty—Counterclaim.

Action was brought for an alleged breach of warranty respecting a heating plant installed in the plaintiff's residence. The defendants alleged acceptance and counterclaimed for a balance due on a completed contract for furnishing and installing new boilers and connections in place of existing ones, the same to be accepted in full satisfaction of any claim the plaintiff had in respect of breach of warranty. One of the defendants testified that the amount of material furnished under the secondary contract was $468.44; that the time to be charged for was 391 hours; that the plaintiff was to pay all freight and cartage bills, and that the balance due was $163.94. In the absence of evidence to the contrary it was held that there was nothing to do but find for the defendants.—Boutin vs. Andreas, Wisconsin Supreme Court, 152 N. W. 822.

Safe Place to Work.

In a steam fitter's action for injuries received while walking through a passageway in the defendant employer's establishment to a room in which he was at work, it appeared that he was injured by bales thrown down by laborers employed in the same establishment, who neglected to warn him or to comply with the defendant's order to place in the passage warning signs provided for just such an occasion. The Pennsylvania Supreme Court held that a verdict was properly directed for the defendant.—Larsen vs. John T. Bailey Co. (Pa.), 94 Atl. 1057.

Water Heater Patents.

The federal district court, W. D. Pennsylvania, holds that the Shook patent, No. 993,723, for an instantaneous gas water heater, the essential feature of which is the use of a single gas valve in combination with thermostatic controling means, is void, on the ground that the patentee was not the original and first inventor of such feature, which is disclosed in the Walker patent, No. 896,100.—Pittsburgh Water Heater Co. vs. Beler Water Heater Co., 222 Fed. 950.

Owner's Liability to Contractor for Delays.

Under contract with a county, a company installed heating and ventilating, plumbing and other systems in a public building. Delays were occasioned the company by the failure of other contractors to keep abreast of the work, and the company sued the county for damages under the contract on account of such delay. The contract provided in one article that if the contractor should be delayed in the prosecution or completion of the work by the act, neglect, or default of the owner, architects, or any other contractor employed by the owner on the work, the time fixed for the completion of the work should be extended for a period equivalent to the time lost by such delay; and the next article provided that the owner agreed to provide all labor and materials essential to the conduct of the work, not included in the contract, in such maner as not to delay the progress of the work, and in the event of failure so to do, thereby causing loss to the contractor, the owner should reimburse the contractor. It was held that the clause in the latter article

requiring the owner to provide labor and materials referred only to such labor and materials as the owner himself was required to furnish, and did not render the owner liable for delay to the contractor caused by delay in the work being done by other contractors. As the parties expressly provided for delays through two different causes, nothing could be implied different from that which was expressed by the language employed.—W. G. Cornell Co. vs. Schuylkill County, C. C. A., 222 Fed., 876.

Installing Mechanical Equipment with Limited Facilities.

Some of the conditions actually encountered in connection with the delivery and setting up of apparatus for the Chinese Government Bureau of Engraving and Printing, in Peking, China, are illustrated in the accompanying views which were taken, during the progress of the work, by R. D. Hopkins, the engineer in charge. These views refer to such interesting details as handling and setting up the boilers, hauling in the heaters, sinking well tubes and erecting engines and dynamos.

Fig. 1 shows two 250-H.P. Babcock & Wilcox water-tube boilers in course of erection. Including foundations the boilers were erected entirely by Chinese labor under Mr. Hopkins's direction. This type of boiler, especially for foreign countries, is shipped completely knocked-down, and the problem of forming up the sections and expanding the tubes at the right angle is somewhat difficult to one not specially trained in this particular work. However, as soon as the mechanics had built up two or three of these sections they displayed considerable care and accuracy in their work, and when fully erected there were extremely few leaks in the tube heads.

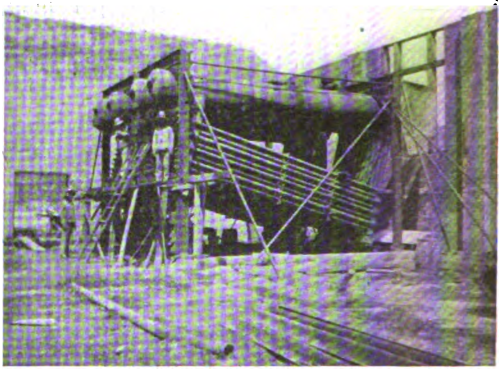


FIG. 1.—TWO 250-H.P. BABCOCK & WILCOX BOILERS IN COURSE OF ERECTION IN PEKING CHINA.

The entire brick work was built up in the usual manner, using native fire brick for linings, bridge walls and paving wash-pits. The common brick were also native made and are as a rule much softer than our ordinary brick, being gray in color.

HAULING OF MACHINERY.

Some difficulty was experienced in hauling some large pieces of machinery through the streets of Peking for a distance of about four miles, especially so during the rainy season when the roads were extremely muddy.

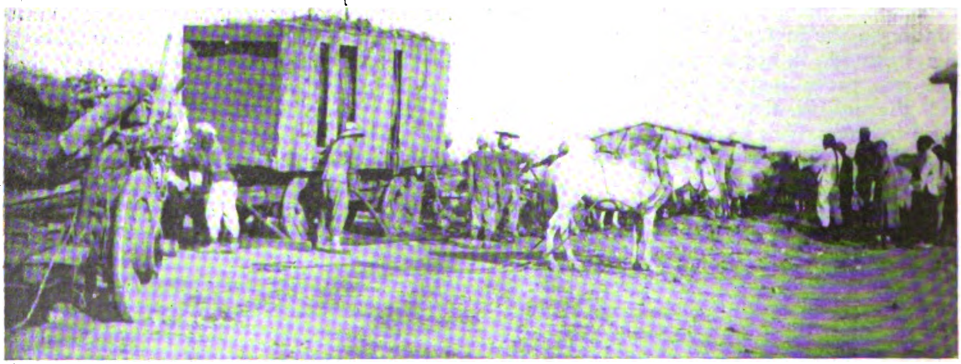


FIG. 2.—METHOD USED TO HAUL 5-TON I. B. DAVIS COMPANY BERRYMAN HEATER.

The accompanying cut shows the method employed in hauling the I. B. Davis Berry-

man heater, weighing five tons. In this case forty animals (horses, mules and don keys) and as many coolies were employed in getting the heater to the building from the railroad station. The heater was mounted on two two-wheel carts lashed together, and the animals and coolies were hitched to the forward cart by ropes and chains.

When a mud road is encountered the Chinese would employ a make-shift windlass, by digging a hole about 12 in. in diameter in the ground some distance ahead of the load, placing in this hole a post guide at the top with a trunnion head. By twisting the post around, the hauling rope was wound up on it, advancing the load by very low stages; all the time with great shouting, arguments of all kinds, and a huge audience of native rag-a-muffins looking on.

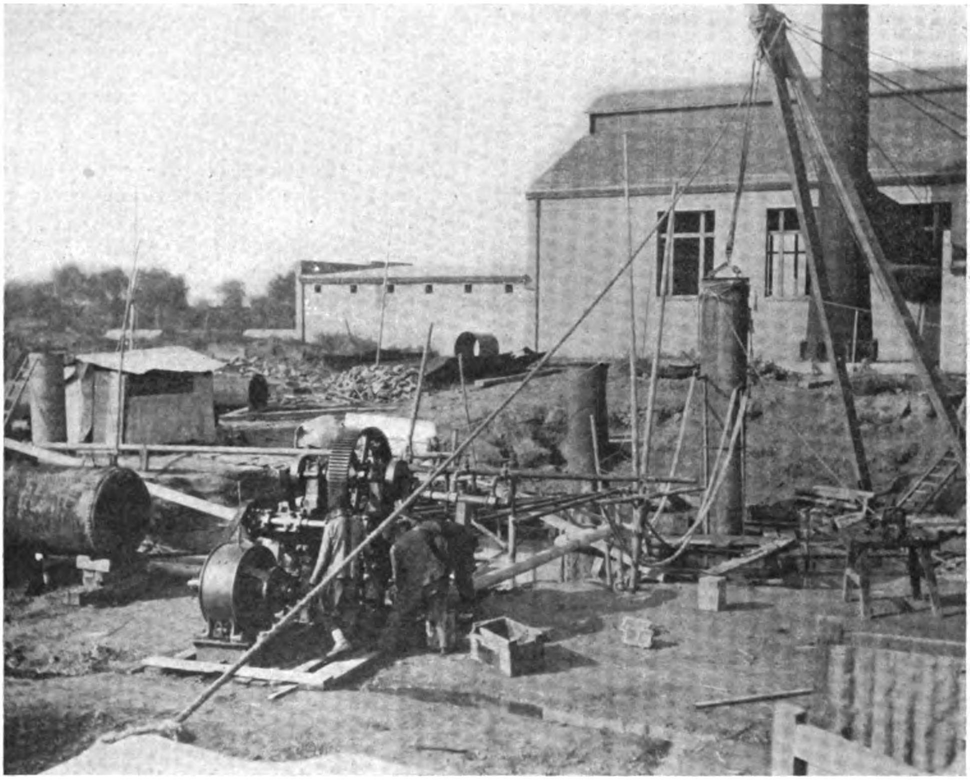


FIG. 3.—SINKING ARTESIAN WELL TUBES THROUGH MUD, QUICKSAND AND GRAVEL.

SINKING WELL TUBES.

Four artesian wells had been driven 5 in. in diameter, 300 ft. deep. Over each was to be dipped a suction tube of ⅜-in. boiler steel 3 ft. in diameter and 35 ft. long, with a bumped head at end, and a cast-iron flange of special construction for slipping over the well pipe.

There was a great deal of soft mud, quicksand, below which was a thick bed of coarse gravel. The surface water at this point stood within 12 in. of the surface of the ground under normal conditions. This meant that excavating for these suction tubes, which were on 11-ft. centres, was quite impossible owing to the diameter of the excavation and the caving in of the soil and the rising of the quicksand. A triplex pump was rigged up, electrically driven, taking suction from the water around the pipes strapped to the sides of the suction wells and pumping it through four 1-in. tube and terminating near the bottom in the form of a nozzle.

The discharge of the pump was connected through a series of pipes and heaters to the pipes attached to the suction tubes, by means of 2½-in. fire hose. Then an air tank was so arranged that the air and water were mixed together. By pumping this mixture through the pipes on the suction tubes as it left the nozzles, the water and

the expansion of air blew out the dirt and sand around the tubes. The tubes were suspended until the hole was blown out to a depth of about 5 ft., and then the tubes lowered down to this depth. It required about 2½ hours to blow out of these tubes 30 ft. The ground around the tubes was filled in to a depth of about 5 ft., where the pump house was erected.

The electricity for driving the pump motor was generated by a Diesel oil engine,, directly connected to a 15 k.w. generator.

ERECTING ENGINES AND DYNAMOS.

Fig. 4 shows the method employed in erecting two 225 Corliss Harrisburg engines, each directly connected to a 150-

FIG. 4.—METHOD OF ERECTING TWO CORLISS HARRISBURG ENGINES, WITH DIRECT-CONNECTED GENERATORS.

K.W. Westinghouse direct-current generator, by the use of improvised horses and the employment of large chain blocks. The Chinese mechanics, Mr. Hopkins states, are usually quite careful in the handling of machinery of this sort. They seem to appreciate the fact that an engine must be properly lined to get desired results.

He had no special difficulty in getting these engines and generators in complete working order in remarkably short time.

Nelson N. Thompson's "Mechanical Equipment of Federal Buildings" is now ready for delivery.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter Given Data on Operating Costs.

First-hand data on operating costs, compiled by George W. Martin, of the New York Service Co., which operates numerous power and heating plants in New York City, were presented by Mr. Martin at the November meeting of the New York Chapter. The meeting was held at the Engineering Societies Building.

The speaker had prepared several charts and tables which were explained at length. The first chart showed a curve of operating expense for office buildings of various sizes, the remarkable feature being that the curve was almost a straight line. All of the figures were for the operating cost per 1,000 cu. ft., based on the entire cubical contents of the building. The costs ran as follows:

Contents of building, cubic feet.	Cost per 1,000 cubic feet.
6,500,000	$1.04
4,500,000	1.32
2,097,800	1.42
2,032,000	1.74
1,600,000	1.75

These figures, the speaker stated, were fairly comparable, because they included practically the entire cost of operation, including coal, electric current, cost of ash removal, wages, etc. An instance of the general lack of knowledge of such costs was shown by the statement that in a building containing 5,000,000 cu. ft., the actual cost of operation averaged $9,000 per year, whereas the architect's preliminary estimate was no less than $20,000. The fact that the plotting of these costs produced so nearly a straight line would indicate, said the speaker, that such a unit may be used to establish operating costs in other buildings of the same type. In this connection he stated that the coal used in the buildings listed was No. 3 Buckwheat, costing $2.50 per ton, burned under forced draft.

Mr. Martin stated that the cost of labor per ton of coal is another phase of the problem upon which he is securing data.

The second chart shown was a coal consumption curve in an office building for two successive seasons, one season without a steam meter and the other with a steam meter installed. An average outside temperature curve was also included in the

chart. The coal consumption, without the meter, ran from 600 tons in January, to 300 tons in May and back to 550 tons in December. After the meter was installed the saving in fuel was very noticeable, the coal used in October, for instance, running 100 tons less than for the same month the previous year. The results with steam meters, he said, had made him a firm believer in the use of these devices to effect coal economies.

The next table presented by Mr. Martin was one showing the cost per 1,000 lbs. of steam produced of the different types of coal in common use. This table was as follows:

Grade of coal.	Market price, net, per ton	Cost per 1,000 lbs. of steam. Test 1.	Test 2.
No. 3, Buckwheat..	$2.50	12.61	12.26
Soft and No. 3.....	3.15	15.6	16.4
No. 2 Buckwheat..	3.15	19	19.6
No. 1 Buckwheat..	3.65	19.86	18.25
Pea	$4.25-4.50	21.7	20

These figures, he explained, showed the relatively high cost of pea coal, although it has the advantage of not needing such frequent attention to the fire, and this fact should be taken into consideration in figuring the cost, as its use would show a saving in the firing cost. The foregoing figures are based on a forced draft in the ashpit of about ½-in., the firemen being instructed to keep the draft so that a handkerchief held near the draft door would be gently drawn in. The tests were conducted for a period of 24 hrs. in each case.

The last chart shown by Mr. Martin gave the cost of generating industrial steam over a period of 11 months. The building was 4,500,000 cu. ft. in volume and it was agreed that anything in excess of 24,500 lbs. of steam per day used exclusively for industrial purposes, was to be paid for on the basis of the cost plus 5%. The table explained how a fair basis was arrived at to determine the relative cost of generating steam for heating and for industrial uses.

President Driscoll, of the New York Chapter, announced that the entertainment committee for the society's annual meeting, of which J. I. Lyle is chairman, had been made up by the appointment of Messrs. F. L. Pryor, N. L. Schloss, H. G. Issertell, Douglas Sprague, G. G. Schmidt and B. K. Strader.

Mr. Chew reported for the committee on amendments to the society's constitution, saying that the final report was not yet completed, but that it would include a proposition to change the date of the society's annual meeting to May. One of the committee had also suggested that the names of candidates for membership in the society be published in the society's Journal. This is a part of the plan to reduce the cost of electing members to the society.

It was announced that the December meeting would be held on December 13, instead of on the third Monday of December, and that the subject of the meeting would be "Vapor-Vacuum Steam Heating Systems." Manufacturers and others interested were invited to attend.

There will be no January meeting on account of the annual meeting of the society. The February meeting will be addressed by M. W. Franklin on a topic to be announced later.

Illinois Chapter Discusses Power Plant Development.

Power plant development, with particular reference to the operating department of the Commonwealth Edison Company of Chicago, was the subject for discussion at the November meeting of the Illinois Chapter, which met in Chicago November 8. The principal speaker was W. L. Abbott, chief operating engineer for the Commonwealth company. An idea of the capacity of the Commonwealth plant was gained by his statement that 5,000 tons of coal were burned a day in the manufacture of electricity. With this consumption the local plants of the Commonwealth Edison Company will deliver 400,000 H.P. during the coming winter on the peak loads. The maximum thermal efficiency, he said, is 16½% of the energy of the coal. The plants generate a kilowatt hour with 11 lbs. of steam. Mr. Abbott told of the arrangements that made it possible for the coal to be burned without smoke in the larger plants, one of the principal items being a high temperature in the combustion chamber. The smaller plants, he added, are still paying their quota to the maintenance of the city smoke department.

The speaker gave some striking figures regarding the action of steam in passing through the company's large turbines. In these units, he said, the steam velocity is no less than 2,000 ft. per second and during the time it passes through the turbine, which is about one-hundredth part of a second, it must expand some 700 volumes. From the time the steam leaves the boiler until it is condensed in the condenser the period is about three seconds.

The heavy duty imposed on the modern steam turbine makes the matter of amortization an important factor. For instance, the turbines installed in the Harrison

Street power plant in 1894 had practically served their usefulness by 1903. A similar experience was had with those installed at a later period. This indicated that the period of usefulness of a large steam turbine was about ten years, as after that it would have to give way to more efficient apparatus.

Other matters taken up by the speaker were the methods used in welding joints in steam mains and the possibilities of the use of electricity for heating purposes.

Massachusetts Chapter Hears Talk on Vacuum Heating.

William G. Snow was the principal speaker at the November meeting of the Massachusetts Chapter, his subject being "Vacuum Heating." The members met November 9 at the Revere House, where a chapter dinner preceded the meeting. There were 45 members and guests present. Mr. Snow's remarks were illustrated by lantern slides. Among the guests, some of whom took part in the discussion, were Edward C. Baldwin, of the State Board of Education; John H. Plunkett, of the State Building Department; Richard A. Lynch, superintendent of building in Boston; Thomas H. Wilson, plumbing inspector for the city building department, and Thomas J. Donellon, of the City of Boston Health Department.

New chapter officers were elected as follows: President, Eugene R. Stone; vice-president, Fred S. Bolz; secretary, Charles Morrison; treasurer, William T. Smallman. Board of Governers: William G. Snow, Frank Irving Cooper and J. W. H. Myrick.

Institution (British) of Heating and Ventilating Engineers.

Following are the new officers of the Institution of Heating and Ventilating Engineers, elected at the autumn meeting of the institution in London, October 12:

President, S. Naylor; vice-president, W. W. Nobbs. As announced last month, papers were read by Walter Jones on "Heat Transmission and Heat Emission" (published in abstract on another page), and by S. Naylor on "A Comparison of Forced Firing and Slow Combustion."

The institution has undertaken some ambitious work in attempting to formulate a set of standard coefficients for heat losses, many of which are to be determined through original investigations and tests under the direction of A. H. Barker at the University College in London.

Another question being taken up is the determination of the heat emission from radiators and pipes "under all conditions." Other suggestions include the preparation of formulae dealing with the flow of water in pipes, and the carrying out of original tests to determine the calorific value of well-known fuels, especially for the use of heating engineers.

Information Wanted on Instantaneous Water Heaters.

Editor HEATING AND VENTILATING MAGAZINE:

Is there on the market any instantaneous or automatic water heater operated with gasoline as fuel, or any except those using gas? WALTER EHA.

Boulder, Colo.

Amount of Humidity Obtained with Air Moistener.

The recent discussion as to whether any of the warm air furnaces now on the market are equipped with air moistening devices that will fulfill the requirements of maintaining 40% to 50% at 70° F. indoors when the entering air is at 32° F. and 25% saturated, has brought out some interesting facts regarding the Filtros air moistener, made by the General Filtration Company, Inc., of Rochester, N. Y. This moistener, although applicable to furnace heating systems, is adaptable to any type of system.

The relative humidity that is obtained with the Filtros air moistener, it is stated, depends entirely upon the number of separate moistener units that are installed. In this respect the system is similar to that of the Air Moistener Co., of Chicago (Steamo air moistener), and of the Savo Mfg. Co., Chicago (Savo air moistener). If a sufficient number of units are placed in the heating apparatus, a relative humidity of from 40% to 50% at 70° F. can be maintained under all outside weather conditions down to a minimum outside temperature of from 5° to 10°.

The General Filtration Company calls attention to the fact that the relative humidity of the outside air is not so important a factor as might at first be supposed, because with all temperatures ranging from 32° down to zero and below zero, the total moisture capacity of the air is so limited. as compared with temperatures ranging from 60° up, that the humidity at the lower temperatures is more or less negligible.

An interesting statement made by this company is that in direct and indirect steam and hot water heating, approximately one-third greater area of the filtrous air mostener is required to maintain a given humidity than in warm air furnace heating, the

reason for this, as given, being that in the latter type of heating much more heat is encountered and consequently a more rapid evaporation.

An Electric Heating Experiment in Spokane.

Much interest is being taken in the experiment in electric heating being carried on under the direction of the Washington Water Power Company in Spokane. A large residence has been fitted out by the company with an electric water heating system. Among the problems that it is proposed to solve is the regulation of the current so that the consumption can be brought down to a competitive basis with fuel. It is admitted that electric current will cost probably twice as much as any other heating medium. As proposed, the electric heating system will run itself, turning on more heat as the temperature drops and shutting off the heat when the opposite limit is reached.

It is recognized that the heaviest heating load will come at the time of the heaviest electric light load and one of the problems to be worked out is the storing of enough reserve heat so that the heating current may be shut off from each house from 5 to 9 p. m. daily. The following description is given of the equipment proposed:

The system is being installed in a 10-room residence in Spokane, a frame building in an exposed location. Being an experiment, it consists of an auxiliary plant directly attached to the present hot water heating system.

The system consists of a 40-kilowatt transformer, installed in a fireproof vault in the basement of the house. This transformer reduces the line voltage, which is 2,300 volts, brought in from the power lines to a low voltage which is then taken to the necessary switches, heaters and controlling apparatus.

The hot water heaters have a capacity of 32 kilowatts and are divided into units of one kilowatt each. The control is automatic by means of thermostatic regulation, which consists of two distinct regulating systems. One thermostat is placed in a central point on the main floor, which controls the water supply to the radiators, and the other thermostat is attached to the boiler and controls the temperature of the water in the boiler, in order to store heat when the full heat is not required in the radiators.

Attached to this system, or rather connected to it, is also a clock mechanism, which cuts the electric heaters off the system at the time of station peak load, and also works in conjunction with the thermostat to regulate the temperature within very close limits.

This is probably the most complete electrical installation which has been thus far installed in any private residence. The object of this installation is to ascertain the practicability of heating residences in Spokane at a reasonable cost, as compared to the present coal and wood methods.

Advantages claimed for the new system are automatic operation, no handling of ashes or fuel, uniform heat, no dust or smoke, always ready for use, no labor required for operation, full heat instantly available without waiting for fire to build up, and practically 100 per cent. efficiency at all times.

The Heat Balance of the Human Body.

The question of temperature is perhaps one of the most important of any in connection with the question of ventilation. Human beings differ in their likes and dislikes, but in one thing they seem to be fairly constant and that is in the amount of heat they require. As between the Esquimo and the African negro, there does not exist a great difference in the amount of heat radiated in 24 hours. Human beings lose heat by convection and combustion in exactly the same way, so that the amount of heat required depends on the difference of temperature and the temperature of the surrounding air. These differences are taken care of by means of clothing. When a man wears clothing, he is surrounded by a volume of air that does not diffuse so that the factor of convection and diffusion become less.

Now, the correct temperature at any place is a variable. It is a function of the natural temperature of the body and of the amount of clothing and condition of clothing at the time. When a man puts on clothing, he is modifying the law to the extent that he is modifying the amount of heat lost by convection and diffusion and increasing the amount of radiation, so that the total amount remains the same. There is one correct temperature and only one, but that is a constant which varies. It depends entirely on the clothing.

If, in the north, where people wear fur and cover large portions of their body, the outside temperature can be one thing, and in the south, where they cover less of their bodies, the temperature can be higher and

the total amount of radiation from the bodies in each case will remain the same.

In order to maintain a fixed temperature in a room, the correct temperature having been decided as a result of taking into consideration the function of the clothing, there is one amount of air for a given temperature of entering air which will maintain a room at this fixed temperature. If the entering air is cold, a very small quantity is needed, because the amount of heat given off by the people is a constant. If, on the other hand, the temperature of the incoming air is high, a very large quantity will have to be brought in.

Throughout all this, there comes the question of humidity. Assuming that each human being gives off a certain definite quantity of heat in 24 hours and a certain definite quantity of moisture which does not vary, we can write an equation for the incoming air if we know the humidity, or if we know the temperature, for the humidity, so that those problems can be solved.

As I use the term, the problem of heating means simply this, that a human being gives off a certain amount of heat in 24 hours and a certain amount of moisture which is evaporated at a certain degree of latent heat of evaporization. Then you determine by the intermediary of clothing and, if necessary, artificial heat, what you require.—M. W. Franklin, *before the Heating Engineers' Society.*

The Importance of Publicity for the Engineeer.

Why should we engineers be interested in publicity? Is there good reasons for departing from the time-honored precept that our achievements are sufficient witnesses to their creator's ability?

The country is burdened with wastefulness where engineering skill might save vast sums. For instance, it is planned to spend a hundred million dollars on highways in New York state without adequate provision for maintenance. It is hardly possible that such a proposition would have been seriously entertained if the public had waited for the opinion of the engineering profession before making a decision. Again: Recently a proposition to spend fifty million dollars on good roads in Ohio was voted upon without any preliminary studies or surveys as to how the money was to be spent. Had the proposition been approved, the money would have been largely wasted under the direction of jockeying politicians.

There is a vast national field for furnishing engineering information to the public, which can be taken care of only by a permanent national information bureau conducted by engineers.

We have technical and research societies without number—so many that the public can hardly be blamed for believing that we are interested in material things only. Perhaps we need a national bureau to conduct and cultivate business relations with the public, including inter-society relations, publicity, employment, and legislation.

All over the country there is a growing protest against the direction of municipal affairs by the lawyer and the politician. The administration of municipal business is largely a function of engineering. Why not enable the public to see this situation in its true light and thereby perform a public benefaction, as well as advance our own interests? Positions for engineers would increase in number, and compensation likewise.—C. E. Drayer, *before the Engineering Section of the Chicago Association of Commerce.*

Comparison of Various Heat Insulating Materials.

The following tabulation, compiled by the United States Bureau of Standards and published as Circular No. 55 of the bureau, gives the thermal conductivities of a number of common materials, also the number of B. T. U. of heat which would pass in one hour through a sheet of the material 1 ft. square and 1 in. thick, if the difference in temperature between the two faces were 1° F.:

Material.	Thermal conductivity, metric units.*	Transmission in B. T. U. per hr., per sq. ft., per in., thickness for each degree F difference in temperature.
1. Silver	1.	2900.0
2. Copper	.9	2600.0
3. Aluminum	.5	1450.0
4. Iron	.14	400.0
5. Rock	.0025 to .009	0.7 to 26.0
6. Porcelain	.0025	7.2
7. Brick	.002 to 005	6.0 to 15.0
8. Glass (ordinary)	.0016	4.6
9. Water	.0014	4.0
10. Plaster (ord'n'y)	.001 to 0015	2.9 to 4.3
11. Wood (hard)...	.0006	1.7
12. Asbestos paper.	.00045	1.3
13. Asbestos felt...	.00025	.7
14. Sawdust	.00018	.52
15. Wood (v'y soft)	.00015	.43
16. Paper	.00013	.38
17. Cork board.....	.00012	.34
18. Wool	.00010	.29
19. Hair felt.......	.00010	.29

20. Cotton wool....	.00009	.26
21. Feathers	.000057	.16

*Thermal conductivity in metric units is the amount of heat in calories which will pass in one second through each square centimeter of a plate 1 centimeter thick, if the difference in temperature between the surfaces is 1° C.

Heating Values of Various Fuels.

The following tabulation gives the approximate amount of heat produced by burning several different kinds of fuel, also the number of gallons of water which could be heated from 32° to 212° F. for 1 ct. if no heat were lost. The figures apply to cost of heat actually supplied to water; true cost depends also on proportion of heat utilized, and this again depends on nature of fuel. Thus gas costing six times as much as hard coal for each heat unit may still be cheaper when heat is needed for only a short time.

Material.	Heating-value.		Price.	Gallons of water which could be heated from 32° to 212° F. for 1 cent.
Softwood	Btu per lb.	8,000	$4 per cord (2 tons)	53.0
Hardwood	Btu per lb.	8,000	$4 per cord (3 tons)	80.0
Soft coal	Btu per lb.	13,000	$4 per ton	43.0
Hard coal	Btu per lb.	13,000	$7 per ton	25.0
Coke	Btu per lb.	12,000	$5 per ton	32.0
Charcoal	Btu per lb.	16,000	$25 per ton	8.5
Fuel oil	Btu per lb.	18,000	$1.25 per barrel (50 gals.)	36.0
Kerosene	Btu per lb.	18,000	$0.10 per gallon	8.3
Alcohol	Btu per lb.	12,000	$0.50 per gallon	1.0
Gasoline	Btu per lb.	19,000	$0.20 per 1,000 gallons	3.5
Natural gas	Btu per cu. ft.	1,000	$0.40 per 1,000 cubic feet.	17.0
Manufactured gas	Btu per cu. ft.	600	$1.00 per 1,000 cubic feet.	4.2
Electricity	Btu per kw hr.	3,400	$0.10 per killawatt hour	0.23
Ice (to absorb heat)	Btu per lb.	160	$0.35 per hundredweight.	*0.32

*Water from 212° F. to 32° F., gallons for 1 cent.

(From Circular No. 55, U. S. Bureau of Standards arranged by Data, Chicago.)

The Rolling Ball Steam Trap.

One of the latest steam traps to be placed on the market is that known as the J-M steam trap, manufactured and sold by the H. W. Johns-Manville Company, of New York. The unusual construction of this trap lends special interest to the story of its design and development which was told by Prof. C. S. Brown, of Vanderbilt University, Nashville, Tenn., at a recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers. Prof. Brown, it will be recalled, was the designer of the D. G. C. valve, which was entirely independent of floats or of thermostatic elements such as had been previously used in devices of this character. This device depended for its action on the vacuum produced between two co-operating surfaces, that of a valve and valve-seat, by a jet of steam.

Since the disposal of his rights in the D. G. C. valve, Prof. Brown, appreciating that ultimate results in the way of simplicity and effectiveness had not been reached in this line, turned his thoughts to new methods of accomplishing the same purposes and very soon conceived of the rolling float device. He had doubts, however, as to its effectiveness in the discharge of air.

EXPERIMENTAL DEVICE MADE OF GLASS.

The first device produced consisted of a float made from a small spherical incandescent lamp bulb, from which the socket connection and filament were removed; the glass bulb was weighted with mercury to give it approximately 50 per cent. submergence in water. This was enclosed in a glass case, from which suitable tubes were laid for inlet and discharge connections.

This apparatus was placed on a radiator operating under gravity conditions with a steam pressure approximately 1 lb., and the operation of the float on its valve seat was studied through the glass casing.

This first experimental device demonstrated the exceedingly satisfactory action of the apparatus, not only in freely discharging water, but in discharging air; not only was the air discharged freely when the water level was sufficiently high to cover or seal the orifice, but this action continued when the pressure was increased to such an extent as to raise the water level around the float so that it stood as much as ¾ in. above the top of the orifice.

Following these experiments other glass floats were made and a few spherical copper floats obtained. These were put into use as drain valves for radiators operating under varying conditions in the writer's laboratory. These radiators were kept in continual use for several months in order to determine the dependability of the device under conditions of normal service. The steam in these radiators was shut off and turned on frequently, so as to approximate normal conditions of operation as closely as possible, and the device was demonstrated to be quiet and dependable in all its functions.

It was early appreciated that the apparatus, while suitable for the drainage of vessels condensing only small quantities of steam, was also equally adaptable to apparatus in which the rate of condensation was very high, and very shortly after the completion of the preliminary experiments, a number of steam traps of considerable size operating on this principle were manufactured and put into immediate use.

PRACTICAL APPLICATION OF TRAP TO LARGE OIL SEPARATOR.

The first device of this character was built for use on a large oil separator on the exhaust line leading from the Vanderbilt University power plant and supplying steam to its vacuum heating system.

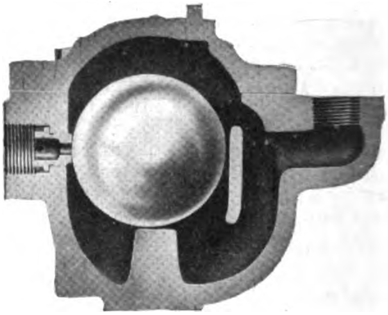
Several traps both of the float and the bucket type had been used on this apparatus and each one had failed to be effective, due to frequent stoppage by sediment and thickened oil from the separator.

The device constructed for this purpose consisted of a 5-in. copper float operating on a discharge nozzle, containing a ⅜-in. orifice. This was installed on the separator in October, 1908, and has now been in use seven years on continuous service, during which time it has never failed to operate successfully. This has been opened occasionally for examination and the float and orifice have been found in perfect condition, although the discharge nozzle is made of ordinary yellow brass. The float after its seven years of service is covered with a blue oxide and presents a beautiful polished surface.

INSTALLATION AT VANDERBILT UNIVERSITY.

Other traps of similar character were built at the same time and installed on both high and low-pressure lines and on vacuum lines. These traps are all still in use, some of them having never been opened since their original installation. Quite a number of radiators at various points in the University installation were also equipped with small traps of this character, most of them consisting of spherical floats of copper 1½ in. diameter, which were inserted directly in the radiator, operating on a brass nozzle, fitted with an orifice of suitable size and discharging into the vacuum lines. All of these have operated satisfactorily since their installation and have required so little attention that the exact locations of some of them have been forgotten.

This device having proven so satisfactory for work of this character, it was used throughout a new system covering about ten acres of ground when the new Medical Department of the University was established; approximately four hundred of these devices both as radiator drain valves and as traps on high pressure and low pressure mains were installed in the various buildings of the Medical College and have been operating since 1910 with results which have been satisfactory in every particular. While this system was designed as a vacuum system and vacuum pumps install-



CONSTRUCTION OF ROLLING BALL STEAM TRAP.

ed, it was never operated as such, it having been found that perfect circulation could be maintained and the water returned to the power plant without the use of vacuum pumps and with a steam pressure on the heating mains of not over 1 lb. This having been found to be the case, the return lines were vented at the various buildings, permitting the discharge of air at various points, while the water of condensation returned by gravity to the power plant. These vent pipes have always been free from vapor, demonstrating conclusively that the traps leak no steam and that any vapor formed by re-evaporation was condensed in the return lines within the buildings, nothing but water returning in the underground lines from the buildings to the power house.

The devices have, therefore, demonstrated their dependability and value by long service, both on vacuum and gravity work, and the writer is not aware that any re-

pairs, either to floats or discharge nozzles have been required during this period.

REQUIREMENTS OF ROLLING FLOAT TRAPS.

Mechanically the device is the equivalent of the ordinary float trap, with its lever, fulcrum and valve. The float itself is the valve, while its radius is the lever at the end of which the force produced by the buoyancy of the float may be considered as concentrated. The fulcrum is at the upper edge of the orifice, about which the float rolls. The valve proper is that portion of the float covering the orifice and its lever arm is the orifice radius.

EXAMPLE SHOWING POWER OF TRAP.

A numerical example may illustrate the power of a device of this sort in operation under steam pressure.

For instance, a float 4 in. diameter, constructed of such thickness of metal as to float one-half submerged, when free would weigh about one-half pound, and would have to be loaded by ½ lb. in order to completely submerge it. This ½ lb. is, therefore, the buoyancy of the float. This acts as if concentrated at its center of gravity, the center of the float, and through a lever arm with respect to the top edge of the orifice equal to the radius of the float, or 2 in. The moment of this buoyancy with respect to this point is, therefore, ½ lb. × 2 in = 1 in. lb.

If it is assumed that the diameter of the orifice is ¼ in., the area of such an orifice is about one-twentieth of a square inch; a pressure of 160 lbs. per sq. in. in the trap would produce a pressure of 1/20 × 160 lbs. or 8 lbs. of the area of the orifice. This pressure of 8 lbs. on the orifice acts as if concentrated at its center of gravity, that is, its center, which is ⅛ in. from the edge of the orifice. The moment of the orifice pressure is 8 lbs. × 1 in. lb. This is exactly equal to the moment of the float with respect to its fulcrum. In other words, the maximum capacity of a 4-in. float to operate on an orifice ¼ in. diameter would be reached when the pressure within the trap was 160 lbs.

CAPACITY OF ROLLING FLOAT TRAP TO DISCHARGE AIR.

One of the most important characteristics of the rolling float trap is its capacity to discharge air. This feature is of primary importance for drainage of radiators, heating coils, steam mains, cooking utensils, laundry machines, glass coils and other units, which otherwise would become air bound and have their effective operation thereby prevented. Air binding also interferes with the operation of a trap itself by preventing the free inflow of water. Unless provisions are made in steam traps for the elimination of air, serious accidents to steam-operated apparatus are likely to occur, due to the failure to discharge the water of condensation and the consequent filling of the system with water. The rolling float trap has a lateral discharge orifice which is relatively close to the surface of the water when the trap is in operation. By properly proportioning the face of the nozzle containing the discharge orifice, the air can be made to pass out through the orifice even when the operating water level is considerably above the orifice.

With small traps for use on radiators, it has been found desirable to use a broad-faced orifice plug of such diameter that under ordinary operating conditions the water level would not submerge the plug, as, if this occurs, the space between the plug and float becomes sealed with water and the air discharge is not effective.

It has been found, however, with larger devices that there is an air discharged even when the orifice plug is deeply submerged. Under such conditions, particularly if the discharge is rapid, a pair of small vortices form, leading from the surface of the water to the orifice, thereby furnishing passageways for the outflow of air.

It might be inferred that after the discharge of such air as might have accumulated in a trap of this character thereafter steam would flow at a similar rate. However, experiment demonstrates that there is a materially different action when steam is present. In the first place the passageway for air at the orifice consists of two exceedingly thin openings, one on each side of the point of contact between the float and the orifice. While flowing air tends to keep these clear of moisture, steam tends to fill these openings with moisture, and therefore, is impeded in its flow to the orifice.

It is well known that very thin cracks or leaks in air pipes carrying air under pressure will leak very rapidly while the same openings carrying steam will not leak appreciably. In other words, compressed air piping must be constructed with much greater care than steam in order to eliminate leaks. It is possible that similar causes permit relatively rapid air discharge through the above described openings, while they do not permit the overflow of steam in appreciable quantities.

An important feature also is that the outlet orifice is not easily stopped up. In case particles of sediment are carried to it the oscillating action of the float tends to grind them up into smaller particles and

they are swept through the orifice and discharged.

In order that this action may be more certain the orifice is made very short, discharging into an opening of much larger area than itself, so there is little opportunity for it to become clogged with dirt.

In the smaller floats, the form of the float and its free action make it possible to utilize it as a check valve to prevent back flow. In case this is desirable an inlet nozzle with a suitable seat for the float to rest on makes this device operative as a check valve.

NEW DEVICES

New Types of the Steamo Air Moistener.

The rapid growth of humidification by the use of steam, and the increasing demand for the Steamo air moistener has made necessary the development of new types of this device, which are shown herewith. The principle underlying the operation is of interest and its explanation will assist in an understanding. The device consists briefly of a silencer through which steam flows and in which noise is eliminated. This silencer is surrounded by a steam jacket to prevent condensation. The flow of steam is controlled by a valve.

As shown by Fig. 1, the base is threaded on the inside for connecting to the top of a vertical pipe, through which steam enters and by which condensation returns. A passage in the lower part of the moistener leads to the control valve from which it extends to the silencer chamber. Steam entering by this passage expands in the chamber surrounding the silencer, through which it penetrates to a central passage and is designed to escape thence to the atmosphere as a noiseless, dry, soft vapor.

As shown, the steam passage, where it enters the silencer chamber, is extended to a point above the bottom, forming a separator or water catcher, intended to assist in the efficient working of the device.

It was found during the experimental period that in the case of residence work, for example, when steam came on in the morning, as it entered the cold moistener, condensation accumulated in the silencer. This resulted in a sputtering noise which continued until this water had evaporated. After that, the operation was noiseless. Although this noise continued for only a few

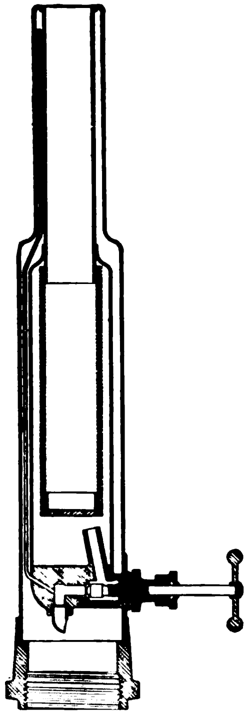


FIG. 1.—SECTIONAL VIEW OF SINGLE PIPE TYPE.

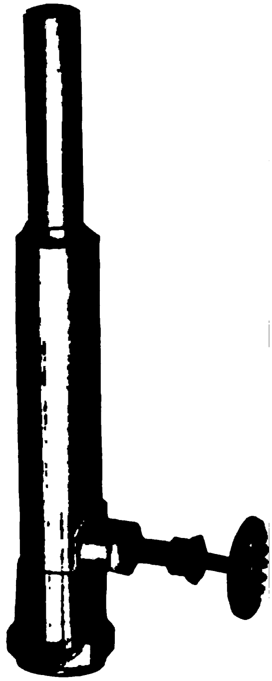


FIG. 2—SINGLE PIPE TYPE.

minutes, it was objectionable, especially in the early morning. With the separator, however, condensation drops into it, remaining to be evaporated a little later, and this, it is stated, entirely eliminates the starting noise.

The successful operation of this device is based largely upon the work of the steam jacket, as unless the silencer is kept hot and dry, it will not only cause condensation and discharge of water, but produce noise as well. Therefore, as will be observed, the jacket is so constructed as not only to keep the silencer chamber hot, but also to heat its long outlet passage. In this way, the entire air moistener proper is protected from cooling influences, so that condensation occurs only in the jacket and drains back. Air binding of the jacket is prevented by a pipe which reaches from the top of the jacket to the valve chamber, insuring a constant flow of steam from the top of the jacket as well as from the lower part by way of the main inlet.

Fig. 2 is an exterior view of the single pipe type of which Fig. 1 is a section. It is made in three sizes: Nos. 3, 4 and 5 with ¾ in., 1 in. and 1¼ in. pipe threading.

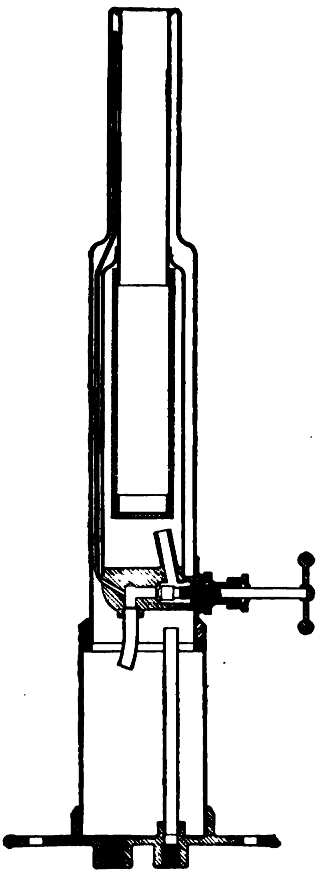


FIG. 3.—SECTIONAL VIEW OF TWO- TYPE.

FIG. 4—TWO-PIPE TYPE.

Connections of such size are essential to insure a sufficiently low velocity in the flow of steam to allow the condensation to flow back against the current. While with the smaller and medium sizes, the one pipe type is economical to install, it becomes impractical in the larger ones on account of the size of the pipe that would be required. The larger sizes are, therefore, of a two-pipe design which allows of the use of quarter and three-eights inch piping.

As shown by Fig. 3, the base is provided with a large separating chamber near the top of which the entrance pipe terminates, the inlet to the controlling valve being so located that any water entering will not be drawn into the silencer chamber but will drop to the bottom of this separator to be carried out by the return pipe. The return water may be handled by connecting with a trap which discharges at a lower pressure than that of the supply, or if desirable to return the condensation into the same pressure as the supply, the return pipe may be so designed as to afford a sufficient water seal to prevent reverse flow in the return pipe. In the latter case, of course, the point of return must be lower than that of supply. Fig. 4 is an elevation of this type, which is used mostly for industrial purposes, large offices, etc.

The No. 2 size has proven to be of about the capacity required to humidify the space which is heated by an average sized radiator. It is, however, designed for attachment to radiators. But as it is desirable to have the means of heating and humidifying separate, this combination is had in those cases where vertical steam risers are employed, by attachment of an equivalent size to the riser. For this purpose the No. 2 riser type, shown in Fig 5, has been devised. This has a long stem, carrying it a proper distance from the riser, into which it screws by a ⅜ in. pipe thread. The slope of the connection gives ample drainage from the jacket and the extension of the inlet pipe into the riser, insuring not only dry steam but preventing the velocity interfering with the drainage. This and types Nos. 1 and 2 embody the same interior features as shown in the sectional view, differing only in the way they take steam and discharge condensation, as they screw directly into the riser or radiator without the intervention of any piping.

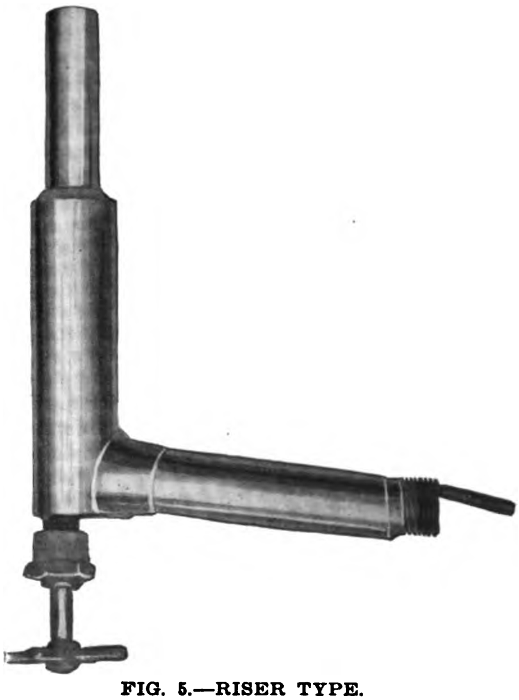
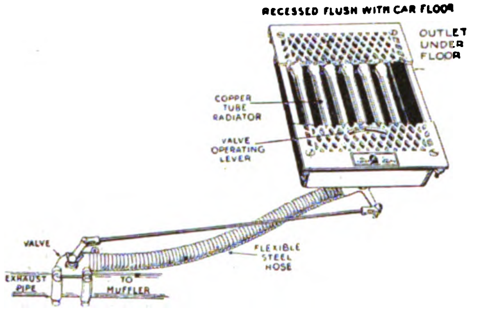


FIG. 5.—RISER TYPE.

The Steamo air moistener is manufactured and sold by The Air Moistener Co., 28 North Market Street, Chicago.

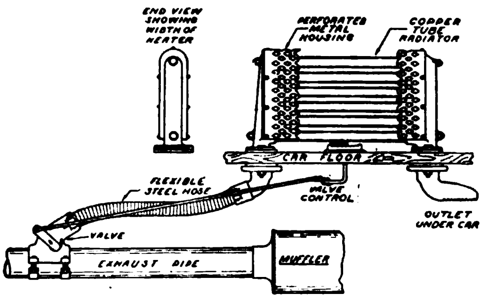
Heater for Automobiles.

A unique device for heating the interiors of automobiles by utilizing the waste heat from the engine has been placed on the market by the Perfection Spring-Service



FLOOR TYPE OF AUTOMOBILE HEATER.

Company, Cleveland, O. It is called the Perfection heater. As shown by the accompanying illustrations, the floor type consists of a series of seamless copper tubes assembled into a manifold at each end. These radiating parts are carried in a rust-proof under-casing. The top plate, mounted flush with the car floor, is buffed and polished. The floor space occupied by the



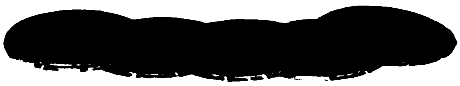
VERTICAL TYPE OF AUTOMOBILE HEATER.

heater is 9¼ in. wide by 13½ in. long, while the depth over all is 2½ in. In this space over 200 sq. in. of radiating space is provided.

The vertical type is similar to the floor type, except that the heat control lever is located as a separate unit wherever desired. For this type a floor space of 3¼ in. by 15⅞ in. is required.

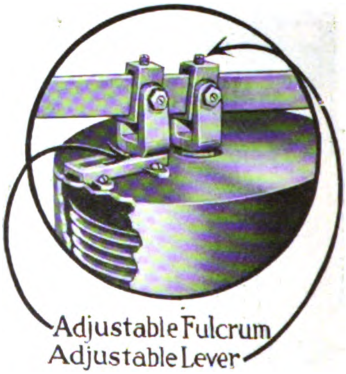
A Unique Metal Diaphragm Valve.

Something unique in the way of a metal diaphragm valve, applicable to any apparatus requiring a diaphragm, such as diaphragm valves for radiators, blast coils, hot water tanks, etc., is a product of the National Regulator Co., Chicago. It is called the "Metaphram." It comprises a number of separable, collapsible, corru-



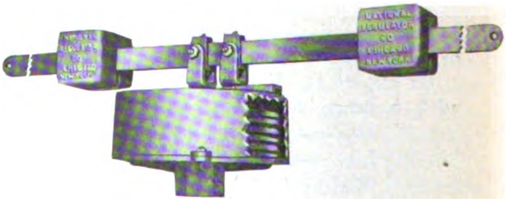
THE DIAPHRAGMS OF THE METAPHRAM VALVE.

gated metal discs, connected by thread studs, making it possible to shorten or lengthen the diaphragm according to requirements. On the edge of each disc is a series of projections to enable the dia-



CONSTRUCTION DETAIL OF THE METAPHRAM.

phragm to be assembled or taken apart with the hands. There are but three parts to the valve—the spider, the car or top and the diaphragm. By removing the spider from the diaphragm the valve can be readily packed. Another advantage mentioned for this device is that if it should be necessary to remove a diaphragm it can be done by hand.



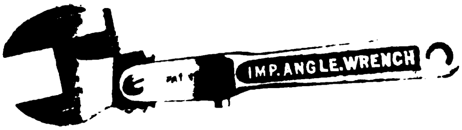
TYPE OF METAPHRAM FOR PRESSURE AND VAPOR HEATING.

The application of the "Metaphram" to boiler regulators is shown by the accompanying illustration. This device is un-

usual on account of its universal adjustment feature, permitting it to be adapted to either pressure or vapor and to any size or style of boiler.

An Adjustable Handle Angle Wrench.

An adjustable handle angle wrench, incorporating a number of unusual features, has recently been brought out by the Imperial Tool Company, Bloomington, Ill. The arrangement of the adjustable jaw



ADJUSTABLE HANDLE ANGLE WRENCH.

permits it to take any tap up to 1¼ in. at eight different angles, or the tap can be turned in close quarters by ratchetting the handle one or more notches at a time in either direction, by pressing the ratchet button. When the button is released, the handle is locked rigidly.

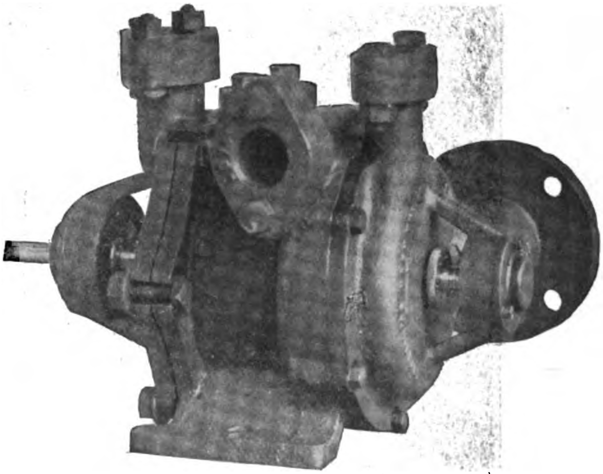
This wrench, it is stated, will take the place of many different sizes, styles and types of wrenches. It has been found to operate in positions and at angles where, it is stated, no other wrench can be used.

The manufacturers lay emphasis on the point that it is not a novelty wrench, but a practical tool, made of high grade material and capable of standing hard usage. It is made and guaranteed by the company, which manufactures various types of wrenches.

New Line of Turbine Vacuum and Air Line Pumps.

An interesting development in vacuum and air line pumps is announced by the Chicago Pump Company, Chicago, Ill., in the form of the Nash hydro-turbine vacuum and air line pumps which this company is now offering to the trade. The vacuum pump is designed for creating and maintaining a vacuum on a heating system and at the same time for returning the water of condensation directly to the boiler. The air line pump is for use in maintaining a vacuum on an air line vacuum heating system where only the air is exhausted from the system, the condensation water flowing back to the boiler by gravity.

The Nash hydro-turbine pumps, it is pointed out, have no wearing parts. The vacuum pump has but two bearings; these are on the outside of the pump and are grease lubricated. They have radial ball bearings and are found to require attention about once or twice a heating season. The vacuum is created and maintained by a hollow air impeller with projecting blades. This impeller revolves in an elliptical casing, partly filled with water. There are inlet and outlet ports at properly located points in the casing which draw the air into the casing when the water is at one



NASH HYDRO TURBINE AIR AND WATER PUMP FOR VACUUM HEATING SYSTEMS.

certain position, forcing the air out through the outlet ports by the water as it is forced to the narrowest point of the casing by the rotating impeller.

The pump and motor are mounted on an iron base and are direct-connected by a flexible coupling. In the pump casing there is a second impeller which handles the water only. This impeller pumps the water directly into the boiler.

An important feature noted in connection with this pump is that the air and water enter a receiver where the air and water are separated, the air impeller taking the air from the upper part of the receiver and discharging it into the atmosphere. The water impeller takes the water from the lower point of the receiver, discharging same directly into the boiler. As there is eight times more air than water returning from a heating system, only one

eighth of the volume is pumped against the boiler pressure, the balance being discharged into the atmosphere. In this manner, it is stated, a saving is effected in comparison with the use of such pumps as are obliged to pump the entire quantity of air and water returning from the heating system against the maximum boiler pressure.

These pumps are described with further details in the company's Bulletin 31.

An Automatic Household Refrigerator.

An interesting type of small electric refrigerator, capable of providing the artificial chilling and ice necessary for table use by the average household, was shown at recent electrical expositions in New

WILLIAMS ELECTRIC REFRIGERATING AND ICE MAKING MACHINE INSTALLED IN STANDARD ICE BOX.

York and is illustrated herewith. It is known as the Williams electric refrigerating and ice-making machine and is made by the Electrical Refrigerating Co., Inc., Woolworth Building, New York. The illustration shows the machine mounted on a standard refrigerator. It is made in three sizes—¼ H.P., with a capacity of 150 lbs. of ice daily, price $300; ½ H.P., capacity 300 lbs., price $400; and 1 H.P., capacity 600 lbs., price $550.

The manufacturers state that these machines are not only regulated to maintain a constant temperature, stopping and starting automatically, but they are also constructed to run from one to three years without adjustment or renewal of chemicals. Ethyl-chloride is used as the cooling agent at a pressure of from 6 to 12 lbs. per square inch on the condensing side and at a vacuum of from 15 to 20 in. on the cooling side within the refrigerator.

The machine is driven by an electric motor and the cooling element occupies the space usually devoted to ice in an ordinary household refrigerator. The cooling coils are partly immersed in a brine tank containing receptacles in which small blocks of ice are formed. A temperature variation may be had in different parts of the refrigerator of from 24° F. to 46° F. at the same time. It is stated that the current required is about 2½ K.W.-hrs. for 100 lbs. of ice effect in the course of one day. At the present 8-cent maximum rate in New York City, this would make the cost of artificial cold 20 cents for the ice effect of 100 lbs.

Novel Test on a Molby Down Draft Boiler.

An impressive demonstration of the steaming qualities of the Molby down draft boiler, made by the Molby Boiler Co., 39 Cortlandt St., New York, was furnished in connection with a recent installation in a residence in Schenectady. A No. 477 Molby steam heater was connected to a vacuum heating system, with 2,200 sq. ft. of direct radiation. At the time of the test approximately 500 sq. ft. was connected. The smoke flue was 18 in. by 18 in. and 44 ft. high, the draft being reported as good.

On the day of this test there was a heavy rain all day, the temperature being practically stationary at 60° F. Fire was started at 8:30 A. M. At 9:05 A. M. a pressure of 3½ lbs. showed on the gauge. The pressure ran up so rapidly to 12 lbs., the safety valve blowing off, that a steam connection, 1¼ in. valved, running out of the third story window, was opened gradually to reduce the pressure. In order to keep the pressure down, however, it was necessary to keep the valve wide open. The safety valve on the boiler was blowing the greater portion of the day and it was necessary to open the flue doors occasionally to keep down the steam pressure. The pressure varied during the day from 5 to 12 lbs. To make up the steam losses the cold water supply valve to the boiler was left open during the test.

The boiler was fired with pea coal until the fire came to the top of the slots or gas ports, after which No. 1 buckwheat was put on, 100 lbs. at a time, half on each side

of the boiler. Then more coal was put on top of this. At 2 P. M. 450 lbs. of birdseye buckwheat coal was put on, equally distributed on the two sides, filling the boiler up into the magazines. At this time there was 5 lbs. of steam in the boiler. Within the next 30 minutes the pressure went up to 6½ lbs., where it remained until 5:30 P. M., the end of the test.

At 5:30 all the drafts were closed, also the damper in the smoke pipe, but the pressure did not go down. The front flue doors were then opened. This relieved the pressure, allowing the steam outlet on the third floor to be closed. Before leaving for the night, 450 lbs. more of birdseye coal was put on the fire, equally distributed on each side.

It was the intention to burn out all of this fuel to ascertain the condition of the ashes after the test, although the manufacturers do not recommend the use of such fine coal, as it is likely to sift through the grate. It was demonstrated that one-third No. 1 buckwheat coal can be used with pea coal in this type of heater without any disadvantage in securing thorough combustion.

New York Correspondence School of Heating and Ventilation.

A correspondence course in heating and ventilation has recently been inaugurated by James A. Donnelly, of New York. According to a circular accompanying the announcement, the course is intended especially for those who are not able to attend the various classes on this subject. It has been prepared for those who are already in the heating business or allied lines, but is limited to the design of direct heating systems and will be completed in ten lessons.

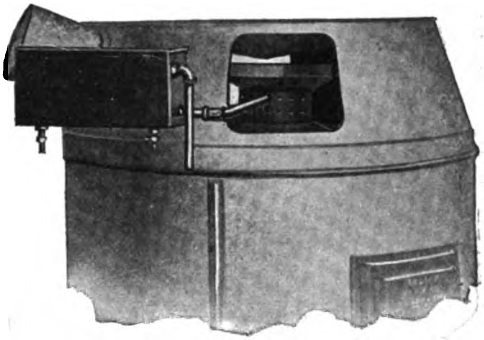
A number of problems illustrative of the work being covered will be submitted to the students, typical ones being solved in order to show the method followed. Those that are solved will be checked and returned, and any particular questions pertaining to the work in hand will be answered.

This procedure is similar to that of the New York School of Heating and Ventilation which was conducted a few years ago under the direction of James M. Harrison. In that case the lesson sheets were later bound under one cover and sold outright, the student then determining upon what subjects, if any, he desired instruction.

The fee for the new course compiled by Mr. Donnelly is $10.00. H. R. Innis, 132 Nassau Street, New York, is the secretary.

Trade Literature.

Kelsey Automatic Humidifier, for use with the Kelsey system of warm air heating, is called to the attention of the trade in a circular which illustrates and describes the device in detail. It is manufactured by the Kelsey Heating Co., Syracuse, N. Y. The



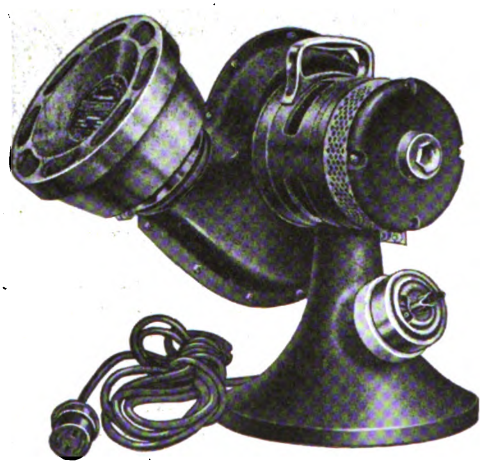
KELSEY HUMIDIFIER IN WARM AIR CHAMBER, SHOWING PIPE CONNECTION TO STORAGE TANK.

location of the humidifier in the warm air chamber of the furnace is in accord with the recommendations made by one of the speakers at the recent meeting of the Heating Engineers' Society. A small galvanized pipe runs from the humidifier through the casing at the top to a storage tank located near the furnace. A float located in the container makes the flow of water automatic. It is stated that with this apparatus the relative humidity is increased from 25% to 50%, depending upon the intensity of the fire. In a test made before the humidifier was placed on the market, it was found that a relative humidity of from 25% to 30% was obtained at 70° F. when the entering air was at 10° F.

Gorton Self-Feeding Boilers are brought to the attention of the trade through the publication of a new catalogue covering this line, issued by Gorton & Lidgerwood Co., New York. A note on the title page states that "all boilers built to the A. S. M. E. standard." Broken views show the construction of these boilers in detail, including the wrought plate tubular boiler shell. An illustration is also included of the grate and fingered ring which is a feature of this line. This is so arranged that the base front can be unbolted and removed, and the entire grate or a single bar easily replaced. It is stated that the grate and fingered ring combined have 50% more air space than is usually found in grates of the same diameter. The Gorton soft coal steam boiler is also shown. The catalogue concludes with the company's well-known guarantee, which is flat, "providing the boiler is properly connected to a chimney flue hav-

ing a good and sufficient draft, and that all cellar piping is well covered and the boiler is run according to our printed directions." Size 4¼ x 7¼ in. Pp. 32.

ELECTRIC AIR HEATER AND BLOWER, designed to meet the demand for a small successful electric heater, has been placed on the market by the B. F. Sturtevant Co., Hyde Park, Mass., and is described in the company's Bulletin 219. The set consists of a motor-driven fan discharging air through heating coils placed in an aluminum casing. The apparatus is port-



STURTEVANT ELECTRIC AIR HEATER AND BLOWER.

(Fan outlet can be turned so as to discharge in any direction. Made in five different sizes. Air temperature is controlled by switch.)

able and can be used in the same way as electric cooking utensils in connection with any wiring system. It is useful for heating rooms quickly, especially in the fall or spring when the heating apparatus is not in operation. It may also be used for drying, for blowing the furnace, for ventilating purposes in the summer time and for various operations in industrial work. Its use in the garage has been found to be very effective. Size of bulletin 6½ in. x 9 in. Pp. 12.

IDEAL HEATING JOURNAL for November, 1915, the periodical of the American Radiator Co., Chicago, has an interesting article on the test of a sylphon regitherm on a central steam heating system in Indianapolis. Another article is entitled "Rules for Figuring Mechanical Ventilation in Theatres," with especial reference to the Chicago ventilation ordinance. The opening item tells of the use of wall radiators in tobacco barns for curing tobacco.

HONEYWELL TEMPERATURE REGULATORS, describing and illustrating the latest improved types manufactured by the Honeywell Heating Specialty Co., Wabash, Ind., are the subject of a new catalogue. The first place in the catalogue is given to the Honeywell Model 8 eight-day automatic thermostat. This device operates not only to raise the temperature in the morning but also to automatically lower it at night at any desired time and to any predetermined degree, with no attention except to wind the clock once a week. The construction of this instrument is made clear in the text. Other thermostats featured are the Model 6 one-day clock thermostat and the Model 4 plain pattern thermostat. All Honeywell thermostat models are made so that their respective parts are interchangeable. Attention is also called to the motors used with these instruments which operate on the regular A. C. house lighting circuit, reduced to 12 volts by a transformer built especially for this purpose. The company also furnishes a spring motor or a gravity motor where desired. The latter type is new. Illustrations are included showing how the regulators should be installed for different kinds of heating systems. Size 3½ x 6 in. (standard). Pp. 22.

ARC FIREPLACE DAMPERS, made by the Arc Fireplace Damper Co., Wilkes-Barre, Pa., are featured in circular matter showing the construction and operation of these unique dampers. The use of the arc principle of construction is explained on the ground that this form is necessary to properly deflect down drafts.

BI-MULTI FANS, made by the Bicalky Fan Co., Buffalo, N. Y., are the subject of circular matter in which it is stated that they are the strongest fans built. They are made to fit any requirement that fans may be used for. It is stated that their design and construction permit them to be operated at the highest pressures without racking and with the minimum horsepower.

FOXBORO RECORDING GAUGES FOR ALL PURPOSES are covered in an exhaustive and well-prepared bulletin (No. 98) issued by the Foxboro Co., Foxboro, Mass. Several new and important improvements are, for the first time, illustrated and described. For instance, the company has recently adopted the round form of case, which is consistent with the instrument design, especially when round charts are used. The company states that it has been able to adopt this type of case on account of the improved actuating movements. More complicated movements, it is explained, which take much more space, do not permit the round case feature. This construction has been found to appeal to engineers generally,

especially when the instruments are to be used on gauge boards, etc. A description is also given of the company's improved helical and diaphragm tube movements, together with other patented features of the Foxboro line. Size 8 x 10½ in. (standard). Pp. 40 (punched for binding).

BETTER BARNS is the title of a new circular sent out by the Globe Ventilator Co., Troy, N. Y., in which it is stated that exhaustive tests and thousands of experiments have shown that fresh air is the greatest of necessities for the preservation of the health of cattle. Globe ventilators are recommended for use on barns, stables, creameries, silos and farm buildings of every character. They are described as strongly constructed of heavy galvanized iron, and practically time-proof. Details are given of present installations of Globe ventilators on some of the largest stock farms in the country, the ventilators in many cases being shipped on repeat orders. The following table is given as an aid in estimating the ventilator size required:

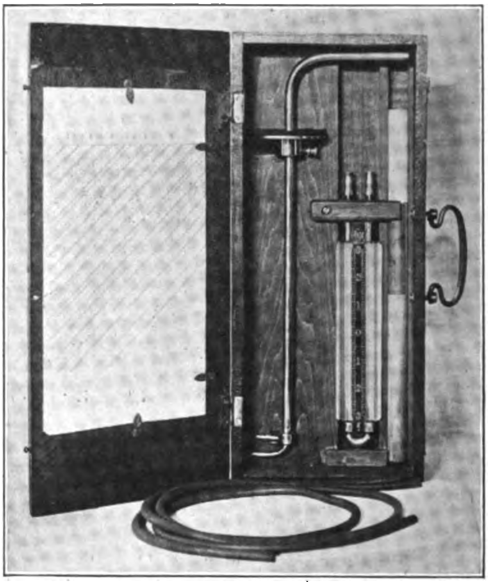
24 in.	10 horses	12 cows
30 in.	16 horses	20 cows
36 in.	22 horses	28 cows

BRISTOL COMPANY'S exhibit of recording instruments at the Panama-Pacific International Exposition is the subject of an article in the *Exhibitors' Weekly Bulletin* for September 25, 1915, published in San Francisco. The statement is made that the Bristol Company's exhibit was the most comprehensive of its kind ever made. The views show the booth from various angles, emphasizing its remarkable artistic appearance.

VALVE WORLD for November, 1915, the monthly periodical of Crane Co., Chicago, contains as one of its principal articles a discussion of "Motor-Operated Gate Valves," by J. E. Stark. The second of the non-technical chats on iron and steel and their application to modern industry is also published in this number, being entitled "The Raw Materials," by L. W. Spring.

OZONATORS FOR COLD STORAGE WAREHOUSES AND OZONATORS FOR STORES are treated in two recent bulletins from the Sprague Electric Works, New York. The machine used is the well-known type of ozonator which the company has had in successful use for several years, but its adaptation to cold storage warehouses for eliminating odors and preventing cross tainting is comparatively recent. The principal use of the machines is in the deodorization of storage rooms after they have been emptied of their contents in order to prepare them for the reception of other products. With these machines, it is stated, a thorough deodorization of a storage room may be accomplished in from two to three hours, in place of several days' airing and frequent whitewashing. The ozonators for use in stores are designed principally to eliminate those odors caused by the class of material carried, such as fish, vegetables, fruits, linoleum, rubber, etc. A typical installation is described, in the department store of Lit Bros., Philadelphia, where ozone is used as an adjunct to the ventilating system in the basement. Size of each bulletin 8 x 10½ in. (standard). Pp. 8 and 4, respectively (punched for binding).

GILBERT AIR MEASURING KIT, for measuring the velocity and volume of air and other gases in ducts, flues, etc., which, it was announced last month, is a new product of the Dwight Instrument Co., 6100 Greenwood Ave., Chicago, is shown in the

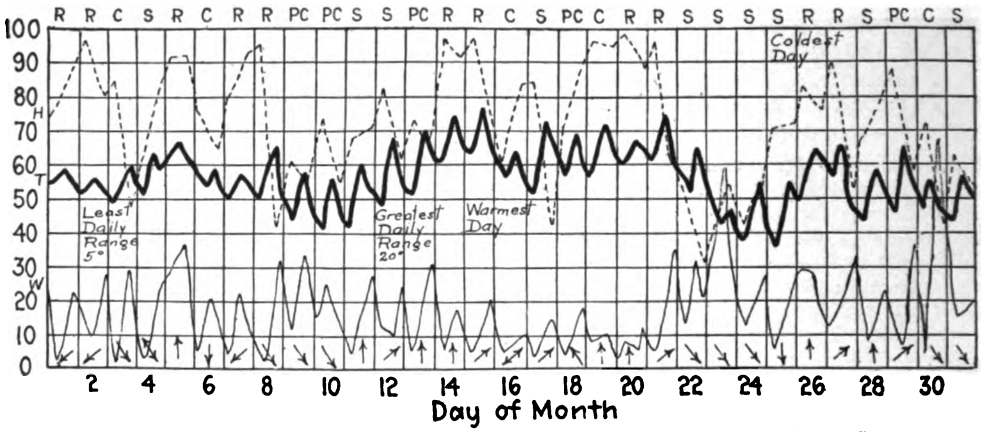


GILBERT AIR MEASURING KIT.

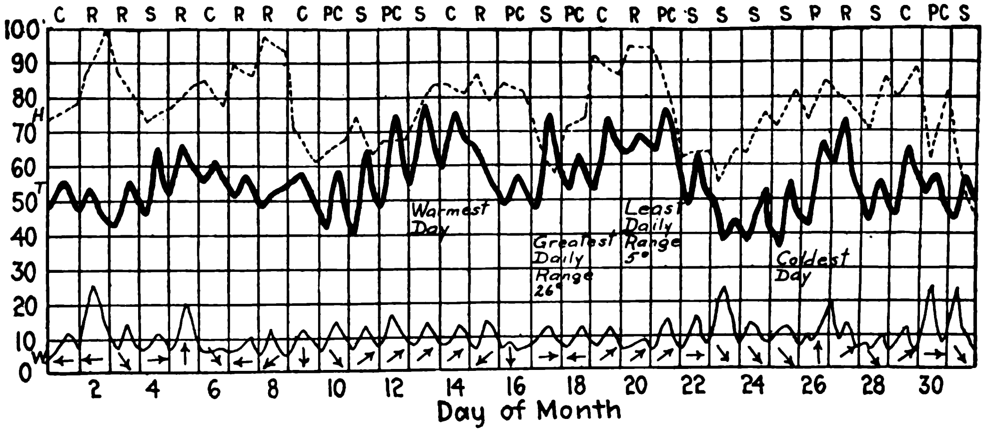
accompanying illustration. The manufacturers state that it can be used satisfactorily by the inexperienced and expert alike. Another point mentioned in its favor is that it eliminates much danger of error by eliminating all mathematics. The kit consists of a standard form of Pitot tube, draft gauge, thermometer, necessary rubber connections, charts for finding volume, velocity, horsepower, etc., without any preliminary calculations, and there is also a complete set of instructions. Charts are of the simple, straight-line type, further simplifying their use.

The Weather for October, 1915.

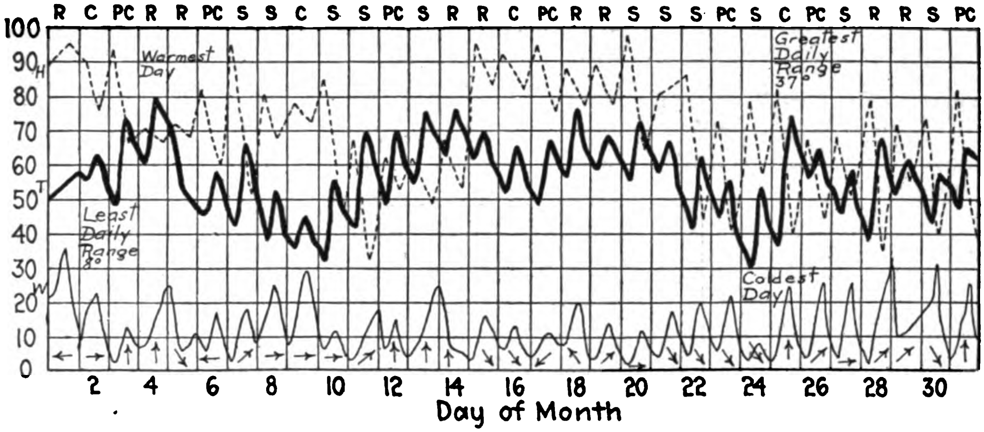
	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F	77	78	80	79	82
Date of highest temperature	15	13	4	3	3
Lowest temperature, degrees F	37	37	30	32	37
Date of lowest temperature	25	25	24	9	9
Greatest daily range, degrees F	20	26	37	25	26
Date of greatest daily range	12	17	25	29	10
Least daily range, degrees F	5	5	8	6	6
Date of least daily range	2	20	2	16	17
Mean Temp. for month, degrees F	56.7	56	56	56.4	61.7
Normal mean temp. for month, deg. F	55.6	52.3	54.9	53.2	58.4
Total rainfall, inches	2.25	2.82	2.84	0.4	0.9
Normal precipitation, this month in	3.71	3.86	2.36	2.55	2.41
Total wind movement, miles	11447	7276	7129	10139	9500
Average hourly wind velocity, miles	15.4	9.8	9.6	13.6	12.8
Prevailing direction of wind	N. W.	S. W.	N. W.	W.	S.
Number of clear days	12	12	14	13	22
Number of partly cloudy days	7	6	8	9	6
Number of cloudy days	12	13	9	9	3
Number of days on which rain fell	14	9	9	5	



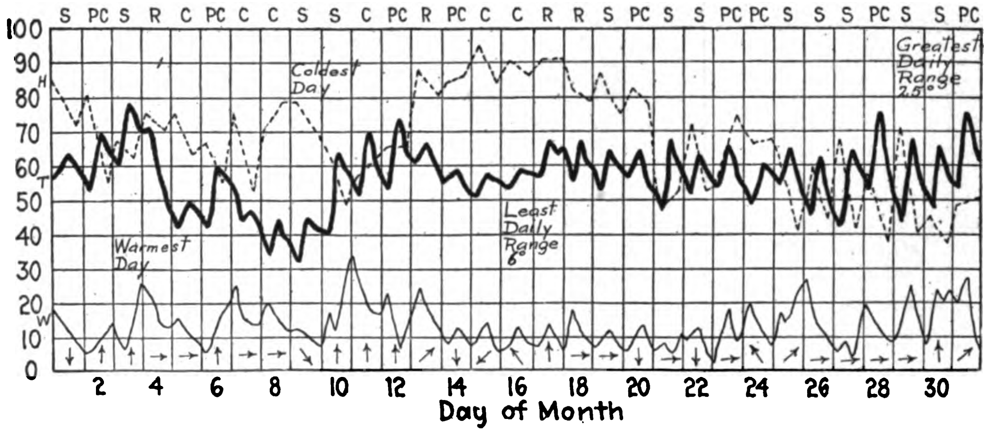
RECORD OF THE WEATHER IN NEW YORK FOR OCTOBER, 1915.



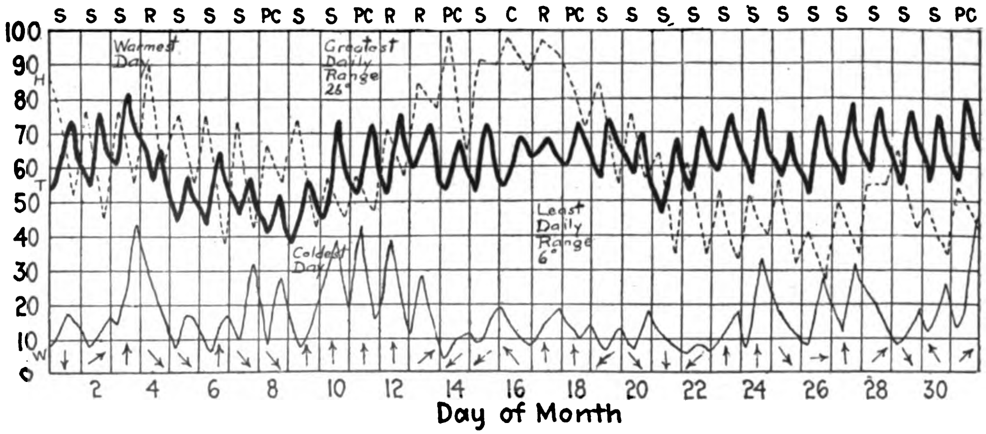
RECORD OF THE WEATHER IN BOSTON FOR OCTOBER, 1915.



RECORD OF THE WEATHER IN PITTSBURGH FOR OCTOBER, 1915.



RECORD OF THE WEATHER IN CHICAGO FOR OCTOBER, 1915



RECORD OF THE WEATHER IN ST. LOUIS FOR OCTOBER, 1915.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.
Heavy lines indicate temperature in degrees F.
Light lines indicate wind in miles per hour.
Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.
S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.
Arrows fly with prevailing direction of wind.

Panama-Pacific Exposition Exhibits.

11—ARMSTRONG CORK COMPANY.

Cork in all stages, from the virgin state on the cork tree to the finished product, is included in the joint display of the Armstrong Cork Company and the Armstrong Cork & Insulation Company, allied corporations, at the Panama-Pacific International Exposition in San Francisco. Attractively arranged in 95 jars are shown as many varieties of cork. Another portion of the exhibit is devoted to heat insulating specialties, including Nonpareil high pressure coverings for steam lines and other heated surfaces, Nonpareil corkboard for insulating cold storage warehouses, etc., Nonpareil cork pipe covering for brine, ammonia and drinking water lines, and, finally, Nonpareil insulating brick.

Moving pictures and specimen bedrooms and living rooms are also features of the exhibit.

The company was awarded the Grand Prize for its display.

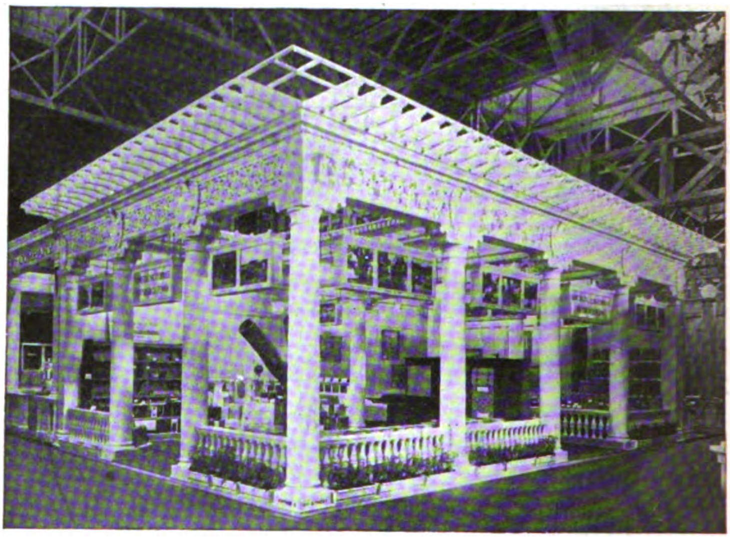


EXHIBIT OF THE ARMSTRONG CORK COMPANY.